Experiments, Notes, &c.

ABOUT THE

Mechanical Origine or Production

Of divers particular

QUALITIES:

Among which is inserted a Discourse of the

IMPERFECTION

OF THE

CHYMIST's Doctrine

OF

QUALITIES;

Together with some Reflections upon the

HYPOTHESIS

OF

ALCALI and ACIDUM.

By the Honourable *Robert Boyle*, Esq;
Fellow of the *R. Society*.

LONDON,
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Directions for the Book-binder; *to be put immediately after the general Title Page.*

THE ſeveral Tracts of this Book are to be bound in the order following, *viz.*

After the Preface of the *Publiſher to the Reader*, and the *Advertiſements relating to the whole Treatiſe*, is to follow,

1. The Tract of *Heat and Cold.*
2. Of *Taſts.*
3. Of *Odours.*
4. Of the imperfection of the *Chymiſts Doctrine of Qualities.*
5. Reflexions upon the Hypotheſis of *Alcali and Acidum.*
6. Advertiſements relating to *Chymical Qualities*, to be bound next after the Title Page to *Volatility.*
7. Of *Volatility.*
8. Of *Fixtneſs.*
9. Of *Corroſiveneſs & Corroſibility.*
10. Of Chymical *Precipitation.*
11. Of *Magnetiſm.*
12. Of *Electricity.*

ERRATA.

IN the Tract of *Heat and Cold*, p. 28. at the end of the page dele *Finis*, and go on to *Exp. IX.* p. 40. l. 21. r. *degree of rapidneſs*. p. 102. l. 15. put a *comma* after the word *before*.

In the Tract of *Corroſiveneſs* and *Corroſibility* read in the current Title on the top of p. 2. and 3. *& ſeqq. Corroſiveneſs and Corroſibility*, not *or*.

THE PUBLISHER TO THE Reader.

TO keep the Reader from being at all surpriz'd at the Date of the Title-Page, I must inform him, that a good part of the ensuing Tracts were Printed off, and in my custody, the last year; and the rest had come out with them divers moneths ago, if the Noble Author had not been hinder'd from committing them to the Press by the desire and hope of being able in a short time to send them abroad more numerous, and by his being hinder'd to do so partly by Remove, partly by the want of some Papers that were odly lost or spoil'd, and partly by the sickness of himself, and divers of his near

Relations. And ſome of theſe Impediments do yet ſuppreſs what the Author intended ſhould have made a part of the Book, which now he ſuffers to be publiſh'd without them, though divers of his Papers about ſome other particular Qualities *have been written ſo long ago, as to have lain for many years neglected among other of his old Writings: Which that he may have both leaſure and health to review, and fit for publication, is the ardent wiſh of the ſincere Lovers of Real Knowledge, who have reaſon to look on it as no mean proof of his conſtant kindneſs to Experimental Philoſophy, that in theſe Tracts he perſeveres in his courſe of freely and candidly communicating his Experiments and Obſervations to the publick, notwithſtanding the liberty that hath been too boldly taken to mention them as their own by ſome later Writers; as particularly by the Compiler of the Treatiſe, entitul'd* Polygraphice, *who in two Chapters hath allow'd himſelf to preſent his Reader with above Fifty Experiments, taken out of*

our

our Authors Book of Colours, *without owning any one of them to Him, or ſo much as naming him or his* Book *in either of thoſe Chapters, nor, that I remember, in any of the others. Nor did I think this practice juſtified by the confeſſion made in the* Preface, *importing, that the Compiler had taken the particulars he deliver'd from the Writings of others. For, this general and perfunctory acknowledgment neither doth right to* particular *Authors, nor, by naming them, enables the Reader to know, whether the things deliver'd come from perſons fit to be credited or not: And therefore, ſince 'tis but too likely, that ſuch Concealment of the Names, if not Uſurpation of the Labours of the Benefactors to Philoſophy, will prove much more forbidding to many others to impart their Experiments, than* as yet *they have to our generous Author; it ſeems to be the Intereſt of the Commonwealth of Learning openly to diſcountenance ſo diſcouraging a practice, and to ſhew, that they do not think it fit that Poſſeſſors of uſeful pieces of*

knowledge ſhould be ſtrongly tempted to envy them to the Publick, to the end onely that a few Compilers ſhould not be put upon ſo reaſonable and eaſie a work, as by a few words or names to ſhew themſelves juſt, if not grateful.

But not to keep the Reader any longer from the peruſal of theſe Tracts themſelves, I ſhall conclude with intimating onely, that what our Author ſaith in one of them concerning the Inſufficiency *of the* Chymical Hypotheſis *for explaining the Effects of Nature, is not at all intended by him to derogate from the ſober Profeſſors of Chymiſtry, or to diſcourage them from uſeful Chymical Operations; foraſmuch as I had the ſatisfaction, ſome years ſince, to ſee in the Authors hands a Diſcourſe of his about the* Uſefulneſs of Chymiſtry *for the* Advancement of Natural Philoſophy; *with which alſo 'tis hoped he will e're long gratifie the Publick.*

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ADVERTISEMENTS

Relating to the following

TREATISE.

TO obviate ſome miſapprehenſions that may ariſe concerning the enſuing Notes about Particular Qualities, it may not be improper to adde ſomething in this place to what has been ſaid in another † Paper in reference to thoſe Notes, and conſequently to premiſe to the particular Experiments ſome few general Advertiſements about them.

† See Tracts about Coſmical Qualities, &c. to which is prefixt an *Introduction to the Hiſtory of Particular Qualities*; Printed at *Oxford* 1671.

And I. we may conſider, that there may be three differing ways of treating Hiſtorically of Particular Qualities. For *either* one may in a full and methodical Hiſtory proſecute the Phænomena; *or* one may make a Collection of various Experiments and Obſervations whence may be gathered divers Phænomena to illuſtrate *ſeveral*, but not all of the Heads or Parts of ſuch an ample or methodical Hiſtory; *or* (in the third place) one may in a more

confin'd way content ones ſelf to deliver ſuch Experiments and Obſervations of the Production, or the Deſtruction or Change of this or that Quality, as, being duly reaſon'd on, may ſuffice to ſhew wherein the nature of that Quality doth conſiſt, eſpecially in oppoſition to thoſe erroneous conceits that have been entertained about it. Of the *Firſt* of theſe three ways of treating of a Quality I pretend not to have given any *compleat* example; but you will find, that I have begun ſuch Hiſtories in my *Specimens* about *Fluidity* and *Firmneſs*, and in the Experiments, Obſervations, &c. that I have put together about *Cold*. The *Second* ſort of Hiſtorical Writings I have given an Inſtance of in my Experiments about *Colours*; but in theſe enſuing Notes, the occaſion I had to make them having obliged me chiefly to have an eye to the diſproval of the errours of the Peripateticks and the Chymiſts about them, I hope I ſhall not be thought to have fallen very ſhort in my Attempt, if I have (here and there) perform'd what may be required in the *Third* way of writing Hiſtorically of a Quality; my preſent Deſign being *chiefly* to give an Intelligent and Hiſtorical Account of the Poſſible *Mechanical Origination*, not of the *various*

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Phænomena of the particular Qualities ſuccinctly mentioned in theſe Notes; though, my *ſecondary* end being to become a Benefactor to the Hiſtory of Qualities by providing Materials for my ſelf or better Architects, I have not ſcrupled to adde to thoſe, that tend more directly to diſcover the *Nature* or Eſſence of the Quality treated of, and to derive it from *Mechanical* Principles, ſome others (which happen'd to come in my way) that acquaint us but with ſome of the leſs luciferous Phænomena.

II. That you may not miſtake what is driven at in many of the Experiments and Reaſonings deliver'd or propos'd in the enſuing Notes about *Particular Qualities*, I muſt deſire you to take notice with me, what it is that I pretend to offer you ſome proofs of. For, if I took upon me to demonſtrate, that the Qualities of bodies *cannot* proceed from (what the Schools call) *Subſtantial Forms*, or from any other Cauſes but Mechanical, it might be reaſonably enough expected, that my Argument ſhould directly exclude them all. But ſince, in my Explications of Qualities, I pretend only, that they *may* be explicated by *Mechanical Principles*, without enquiring, whether they are explicable by any other; that which I need to prove, is,

not

not that Mechanical Principles are the *neceſſary* and *onely* things whereby Qualities may be explain'd, but that probably they will be found *ſufficient* for their explication. And ſince *theſe* are confeſſedly more manifeſt and more intelligible than *ſubſtantial Forms* and other Scholaſtic Entities (if I may ſo call them) 'tis obvious, what the conſequence will be of our not being oblig'd to have recourſe to things, whoſe exiſtence is very diſputable, and their nature very obſcure.

There are ſeveral ways that may be employed, ſome on one occaſion, and ſome on another, either more directly to reduce *Qualities* (as well as divers other things in nature) to Mechanical Principles; or, by ſhewing the inſufficiency of the Peripatetic and Chymical Theories of Qualities, to recommend the Corpuſcularian Doctrine of them.

For further Illuſtration of this Point, I ſhall adde on this occaſion, that there are three diſtinct ſorts of Experiments (beſides other proofs) that may be reaſonably employ'd, (though they be not equally efficacious) when we treat of the *Origine* of Qualities. For ſome Inſtances may be brought to ſhew, that the propos'd Quality may be Mechanically *introduc'd* into a portion of matter, where it was

was not before. Other Instances there may be to shew, that by the same means the Quality may be notably *varied* as to degrees, or other not essential Attributes. And by some Instances also it may appear, that the Quality is Mechanically *expell'd* from, or *abolish'd* in, a portion of matter that was endow'd with it before. Sometimes also by the same Operation the former quality is destroyed, and a new one is produc'd. And each of these kinds of Instances may be usefully employ'd in our Notes about Particular Qualities. For, as to the *first* of them, there will be scarce any difficulty. And as to the *second*, since the permanent Degrees as well as other Attributes of Qualities are said to flow from (and do indeed depend upon) the same Principles that the Quality it self does; if, especially in bodies inanimate, a change barely Mechanical does notably and permanently alter the *degree* or other considerable attribute; it will afford, though not a clear proof, yet a probable presumption, that the Principles whereon the Quality it self depends are Mechanical. And *lastly*, if, by a bare Mechanical change of the internal Dispositi-on and structure of a body, a permanent Quality, confess'd to flow from its substantial Form or inward Principle, be abolish'd,

oliſh'd, and perhaps alſo immediately ſucceeded by a new Quality Mechanically producible; if, I ſay, this come to paſs in a body Inanimate, eſpecially if it be alſo, as to ſenſe ſimilar, ſuch a *Phænomenon* will not a little favour that *Hypotheſis* which teaches, that theſe Qualities depend upon certain contextures and other Mechanical Affections of the ſmall parts of the bodies, that are indowed with them, and conſequently may be aboliſh'd when that neceſſary Modification is deſtroyed. This is thus briefly premis'd to ſhew the pertinency of alledging differing kinds of Experiments and *Phænomena* in favour of the Corpuſcular *Hypotheſis* about Qualities.

What has been thus laid down, may, I hope, facilitate and ſhorten moſt of the remaining work of this Preamble, which is to ſhew, though but very briefly, that there may be ſeveral ways, not impertinently employable to recommend the Corpuſcularian Doctrine of Qualities.

For *firſt*, it may ſometimes be ſhewn, that a *Subſtantial Form* cannot be pretended to be the neceſſary Principle of this or that Quality; as will (for inſtance) hereafter be made manifeſt in the *Aſperity* and *Smoothneſs* of bodies, and in the *Magnetical Vertue* reſiding in a piece of Iron that has been impregnated by a Loadſtone.

ſtone. 'Tis true, that the force of ſuch Inſtances is indirect, and that they do not expreſly prove the *Hypotheſis* in whoſe favour they are alledged; but yet they may do it good ſervice by diſproving the Grounds and Concluſions of the Adverſaries, and ſo (by removing Prejudices) making way for the better entertainment of the truth.

Secondly, we may ſometimes obtain the ſame or the like Quality by Artificial and ſometimes even temporary Compoſitions, which, being but factitious bodies, are by Learned Adverſaries confeſs'd not to have *Subſtantial Forms*, and can indeed reaſonably be preſum'd to have but reſulting Temperaments: As will be hereafter exemplifi'd in the production of *Green* by compounding Blew and Yellow, and in the *Electrical* Faculty of Glaſs; and in the temporary whiteneſs produc'd by beating clear Oyl and fair Water into an Ointment, and by beating water into a froth, and, more permanently, in making Coral white by ſlawing it with heat; and in divers other Particulars, that will more properly be elſewhere mention'd.

Thirdly then, in ſome caſes the Quality propos'd may be either *introduced*, or *vary'd*, or *diſtroy*'d in an inanimate body, when no change appears to be made in the bo-

dy,

dy, except what is Mechanical, and what migh. be produc'd in it, ſuppoſing ſuch a parcel of matter were *artificially* fram'd and conſtituted as the body is, though without any *Subſtantial Form*, or other ſuch like internal Principle. So when a piece of Glaſs, or of clarify'd Roſin, is, by being beaten to powder, deprived of its Tranſparency, and made white, there appears no change to be made in the pulveriz'd body, but a comminution of it into a multitude of Corpuſcles, that by their number and the various ſcituations of their ſurfaces are fitted copiouſly to reflect the ſincere Light ſeveral ways, or give ſome peculiar Modification to its Rayes; and hinder that free paſſage of the beams of Light, that is requiſite to Tranſparency.

Fourthly, as in the caſes belonging to the foregoing number there appears not to intervene in the Patient or Subject of the change, any thing but a *Mechanical* alteration of the Mechanical Structure or Conſtitution; ſo in ſome other caſes it appears not, that the Agent, whether natural or factitious, operates on the Patient otherwiſe than Mechanically, employing onely ſuch a way of acting as may proceed from the Mechaniſme of the matter, which it ſelf conſiſts of, and that of the body

body it acts upon. As when Goldſmiths burniſh a Plate or Veſſel of Silver, that having been lately boil'd lookt white before, though they deprive it of the greateſt part of its colour, and give it a new power of reflecting the beams of Light and viſible Objects, in the manner proper to ſpecular bodies; yet all this is done by the intervention of a burniſhing Tool, which often is but a piece of Steel or Iron conveniently ſhap'd; and all that this Burniſher does, is but to depreſs the little prominencies of the Silver, and reduce them, and the little cavites of it, to one phyſically level or plain Superficies. And ſo when a Hammer ſtriking often on a Nail, makes the head of it grow hot, the Hammer is but a purely Mechanical Agent, and works by local motion. And when by ſtriking a lump of Glaſs, it breaks it into a multitude of ſmall parts that compoſe a white powder, it acts as Mechanically in the production of that Whiteneſs as it does in driving in a Nail to the head. And ſo likewiſe, when the powder'd Glaſs or Colophony lately mention'd is, by the fire, from a white and opacous body, reduc'd into a colourleſs (or a reddiſh) and tranſparent one, it appears not, that the fire, though a natural Agent, need work otherwiſe than Mecha-

Mechanically, by colliquating the incoherent grains of powder into one mass; wherein, the ranks of pores not being broken and interrupted as before, the incident beams of Light are allow'd every way a free passage through them.

Fifthly, the like Phænomena to those of a Quality to be explicated, or at least as difficult in the same kind, may be produc'd in bodies and cases, wherein 'tis plain we need not recurre to *Substantial Forms*. Thus a varying Colour, like that which is admired in a Pigeons Neck, may be produc'd in changeable Taffety, by a particular way of ranging and connecting Silk of several Colours into one piece of Stuff. Thus we have known *Opals* casually imitated and almost excell'd by Glass, which luckily degenerated in the Furnace. And somewhat the like changeable and very delightful Colour I remember to have introduced into common Glass with Silver or with Gold and Mercury. So likewise meerly by blowing fine Crystal-Glass at the flame of a Lamp to a very extraordinary thinness, we have made it to exhibit, and that vividly, all the Colours (as they speak) of the Rainbow; and this power of pleasing by diversifying the Light, the Glass, if well preserved, may keep for a long time. Thus

also

alſo by barely beating Gold into ſuch thin leaves as Artificers and Apothecaries are wont to employ, it will be brought to exhibite a green Colour, when you hold it againſt the Light, whether of the day, or of a good Candle; and this kind of Greenneſs as 'tis permanent in the foliated Gold, ſo I have found by trial, that if the Sun-beams, ſomewhat united by a Burning-glaſs, be trajected through the expanded Leaf, and caſt upon a piece of white paper, they will appear there as if they had been tinged in their paſſage. Nay, and ſometimes a ſlight and almoſt momentany Mechanical change will ſeem to over-rule Nature, and introduce into a body the quite oppoſite Quality to that ſhe had given it: As when a piece of black Horn is, onely by being thinly ſcraped with the edge of a knife or a piece of glaſs, reduced to permanently white Shavings. And to theſe Inſtances of Colours, ſome Emphatical and ſome Permanent, might be added divers belonging to other Qualities, but that I ought not to anticipate what you will elſewhere meet with.

There is yet another way of arguing in favour of the *Corpuſcularian* Doctrine of Qualities, which, though it do not afford direct proofs of its being the beſt

Hypothesis, yet it may much strengthen the Arguments drawn from other Topicks, and thereby serve to recommend the Doctrine it self. For, the use of an *Hypothesis* being to render an intelligible account of the Causes of the Effects or Phænomena propos'd, without crossing the Laws of Nature or other Phænomena, the more numerous and the more various the Particulars are, whereof some are *explicable* by the assign'd Hypothesis, and some are *agreeable* to it, or at least are not dissonant from it, the more valuable is the Hypothesis, and the more likely to be true. For 'tis much more difficult, to finde an *Hypothesis* that is not true which will suit with *many* Phænomena, especially if they be of various kinds, than but with *few*. And for this Reason I have set down among the Instances belonging to particular Qualities some such Experiments and Observations, as we are now speaking of, since, although they be not direct proofs of the preferrableness of our Doctrine, yet they may serve for Confirmation of it; though this be not the only or perhaps the chief Reason of their being mention'd. For whatever they may be as Arguments, since they are matters of fact, I thought it not amiss to take this occasion of preserving them from being lost;

loſt; ſince, whether or no they contribute *much* to the eſtabliſhment of the Mechanical Doctrine about Qualities, they will at leaſt contribute to the Natural Hiſtory of them.

III. I ſhall not trouble the Reader with a Recital of thoſe unlucky Accidents, that have hinder'd the Subjects of the following Book from being more numerous, and I hope he will the more eaſily excuſe their paucity, if he be advertiſed, that *although* the particular Qualities, about which ſome Experiments and Notes, by way of *Specimens*, are here preſented, be not near half ſo many as were intended to be treated of; *yet* I was careful to chuſe them ſuch as might comprehend in a ſmall number a great variety; there being ſcarce one ſort of Qualities, of which there is not an Inſtance given in this ſmall Book, ſince therein Experiments and thoughts are deliver'd *about* Heat and Cold, which are the chief of the four *FIRST QUALITIES*; *about* Taſts and Odours, which are of thoſe, that, being the immediate objects of Senſe, are wont to be call'd *SENSIBLE QUALITIES*; *about* Volatility and Fixity, Corroſiveneſs and Corroſibility, which, as they are found in bodies purely natural, are referrable to thoſe Qualities, that many

Physical Writers call *SECOND QUALITIES*, and which yet, as they may be produced and destroyed by the Chymists Art, may be stiled *Chymical Qualities*, and the Spagyrical ways of introducing or expelling them may be referr'd to *Chymical Operations*, of which there is given a more ample *Specimen* in the Mechanical account of *Chymical Precipitations*. And lastly, some Notes are added *about Magnetism* and *Electricity*, which are known to belong to the Tribe of *Occult Qualities*.

IV. If a want of apt Coherence and exact Method be discover'd in the following Essays, 'tis hop'd, that defect will be easily excus'd by those that remember and consider, that these Papers were originally little better than a kind of Rapsody of Experiments, Thoughts, and Observations, occasionally thrown together by way of Annotations upon some Passages of a Discourse, (about the differing Parts and Redintegration of Nitre) wherein some things were *pointed at* relating to the particular Qualities that are here more largely *treated of*. And though the Particulars that concern some of these Qualities, were afterwards (to supply the place of those borrow'd by other Papers whilst these lay by me) increas'd in number; yet it was not to be expected, that

their

their Acceſſion ſhould as well correct the Form as augment the Matter of our Annotations. And as for the two Tracts, that are inſerted among theſe Eſſays about Qualities; I mean *the Diſcourſe of the Imperfection of the Chymical Doctrine of them*, and the Reflections on the *Hypotheſis of Acidum and Alcali*, the occaſion of their being made parts of this Book is ſo far expreſs'd in the Tracts themſelves, that I need not here trouble the Reader with a particular Account of it.

V. I do not undertake, that all the following Accounts of Particular Qualities would prove to be the very true ones, nor every Explication the beſt that can be deviſ'd. For beſides that the difficulty of the Subject, and Incompleatneſs of the Hiſtory we yet have of Qualities, may well deterre a man, leſs diffident of his own abilities than I juſtly am, from aſſuming ſo much to himſelf, it is not abſolutely neceſſary to my preſent Deſign. For, Mechanical Explications of natural Phænomena do give ſo much more ſatisfaction to ingenious minds, than thoſe that muſt employ *Subſtantial Forms*, *Sympathy*, *Antipathy*, &c. that the more judicious of the vulgar Philoſophers themſelves preſer them before all others, when they can be had; (as is elſewhere ſhewn

at

at large,) but then they look upon them either as confined to Mechanical Engines, or at leaſt but as reaching to very few of Nature's *Phænomena*, and, for that reaſon, unfit to be received as Phyſical Principles. To remove therefore this grand Prejudice and Objection, which ſeems to be the chief thing that has kept off Rational Inquirers from cloſing with the Mechanical Philoſophy, it may be very conducive, if not ſufficient, to propoſe ſuch Mechanical accounts of Particular Qualities themſelves, as are intelligible and poſſible, and are agreeable to the *Phænomena* whereto they are applied. And to this it is no more neceſſary that the account propos'd ſhould be the trueſt and beſt that can poſſibly be given, than it is to the proving that a Clock is not acted by a vital Principle, (as thoſe *Chineſes* thought, who took the firſt, that was brought them out of *Europe*, for an *Animal*,) but acts as an Engine, to do more than aſſign a Mechanical Structure made up of Wheels, a Spring, a Hammer, and other Mechanical pieces, that will regularly ſhew and ſtrike the hour, whether this Contrivance be or be not the very ſame with that of the Particular Clock propos'd; which may indeed be made to move either with Springs or Weights, and may conſiſt of a greater or leſſer number of Wheels,

Wheels, and thoſe differingly ſcituated and connected; but for all this variety 'twill ſtill be but an Engine. I intend not therefore by propoſing the Theories and Conjectures ventur'd at in the following Papers, to debar my ſelf of the Liberty either of altering them, or of ſubſtituting others in their places, in caſe a further progreſs in the Hiſtory of Qualities ſhall ſuggeſt better *Hypotheſes* or Explications. And 'twas but agreeable to this Intention of mine, that I ſhould, as I have done, on divers occaſions in the following Notes, imploy the word *Or*, and expreſs my ſelf ſomewhat doubtingly, mentioning more than one Cauſe of a *Phænomenon*, or Reaſon of an opinion, without dogmatically declaring for either; ſince my purpoſe in theſe Notes was rather to ſhew, it was not neceſſary to betake our ſelves to the Scholaſtick or Chymical Doctrine about Qualities, than to act the Umpire between the differing *Hypotheſes* of the *Corpuſcularians*; and, provided I kept my ſelf within the bounds of Mechanical Philoſophy, my deſign allowed me a great latitude in making explications of the *Phænomena*, I had occaſion to take notice of.

FINIS.

OF THE MECHANICAL ORIGINE OF *HEAT* and *COLD.*

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

LONDON,
Printed by *E. Flesher*, for *R. Davis*
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Experiments and Notes

ABOUT THE

MECHANICAL ORIGINE

OR

PRODUCTION

OF

HEAT and *COLD.*

SECT. I.

About the Mechanical Production of Cold.

HEAT & *COLD* being generally lookt upon as the moſt active among Qualities, from which many other Qualities are deducible, and by which many of Nature's Phænomena, eſpecially among the

Peripateticks, are attempted to be explicated; I ſuppoſe it will be very proper to begin with Inſtances of them to ſhew, that Qualities may be Mechanically produced or deſtroyed. A not uſeleſs Paraphraſe of which expreſſion may be this, That a portion of matter may come to be endowed with a Quality, which it *had not* before, or to be deprived of one that it had, *or* (ſometimes) to acquire or loſe a degree of that Quality; *though* on the part of the Matter (or, as ſome would ſpeak, of the Patient) there do not appear to intervene any more than a change of Texture, or ſome other Mechanical Alteration; and *though* the Agents (on their part) do not appear to act upon it otherwiſe, than after a Mechanical manner, that is, by their bigneſs, ſhape, motion, and thoſe other Attributes by vertue whereof Mechanical Powers and Engines perform their operations; and this without having recourſe to the Peripatetic Subſtantial Forms and Elements,

ments, or to the Hypostatical Principles of the Chymists.

And having here (as in a proper place) to avoid ambiguity, premised once for all, this *Summary Declaration of the sense, agreeably whereunto I would have these Terms understood in the following Notes about the Origine of Particular Qualities; I proceed now to set down some few examples of the Mechanical Production of *Cold* & *Heat*, beginning with those that relate to the former, because by reason of their Paucity they will be quickly dispatcht. And I hope I shall not need to make an Apology for mentioning no greater number; since I scarce remember to have met with any Instances of this kind in any of the Classick Writers of Natural Philosophy.

* See more of this in the Preamble.

EXPER. I.

MY first Experiment is afforded me by the Dissolution of Sal Armoniac, which I have somewhat wonder'd, that Chymists having often occasion to purifie that Salt by the help of Water, should not have, long since, and publickly, taken notice of. For if you put into three or four times its weight of Water a pound or but half a pound (or even less) of powder'd Sal Armoniack, and stir it about to hasten the dissolution, there will be produc'd in the mixture a very intense degree of Coldness, such as will not be onely very sensible to his hand that holds the Glass whilst the Dissolution is making, but will very manifestly discover it self by its Operation upon a Thermoscope. Nay, I have more than once by wetting the outside of the Glass, where the dissolution was making, and nimbly stirring

ring the Mixture, turn'd that externally adhering water into real Ice, (that was ſcrap'd off with a knife) in leſs than a minute of an hour. And this thus generated Cold continued conſiderably intenſe, whilſt the action of diſſolution laſted; but afterwards by degrees abated, and within a very few hours ceas'd. The particular Phænomena I have noted in the Experiment, and the practical uſes that may be made of it I reſerve for another place*, the knowledge of them being not neceſſary in this, where what I have already related, may ſuffice for my preſent Argument.

* Divers of the Phænomena, &c. of this Experiment were afterwards printed Numb. 15. of the *Ph. Tranſact.*

And to ſhew, that not onely a far more intenſe degree of Cold may emerge in this Mixture, than was to be found in either of the Ingredients before they were mingled, but a conſiderable Coldneſs may be *begun* to be produc'd between Bodies that were neither of them actually Cold

before they were put together, I will ſubjoin a Tranſcript of what I find to this purpoſe among my *Adverſaria*.

EXPER. II.

[I Remember that once I had a mind to try, Whether the Coldneſs produced upon the Solution of beaten Sal Armoniac in water, might not be more probably referr'd to ſome change of Texture or Motion reſulting from the action of the Liquor upon the Salt, than to any Infrigidation of the water made by the ſuddain diſperſion of ſo many Saline grains of powder, which by reaſon of their Solidity may be ſuſpected to be actually more cold than the Water they are put into; I therefore provided a Glaſs full of that Liquor, and having brought it to ſuch a Temper, that its warmth made the Spirit of Wine in the ſeal'd Weather-glaſs ma-

manifeſtly, though not nimbly, aſcend; I took out the Thermoſcope, and laid it in powder'd Sal Armoniac, warm'd beforehand; ſo that the tincted Liquor was made to aſcend much nimblier by the Salt than juſt before by the Water; and having preſently remov'd the Inſtrument into that Liquor again, and poured the ſomewhat warm Sal Armoniac into the ſame, I found, as I imagin'd, that within a ſpace of time which I gueſs'd to be about half a minute or leſs, the Spirit of Wine began haſtily to ſubſide, and within a few minutes fell above a whole diviſion and a quarter below the mark at which it ſtood in the water, before that Liquor or the Salt were warm'd. Nor did the Spirit in a great while reaſcend to the height which it had when the water was cold.

The ſame Experiment, being at another time reiterated, was tried with the like ſucceſs; which ſecond may therefore ſerve for a Confirmation of the firſt.]

EXPER.

EXPER. III.

HAving a mind likewiſe to ſhew ſome Ingenious men, how much the production of Heat and Cold depends upon Texture and other Mechanical Affections, I thought fit to make again a Sal Armoniac by a way I formerly publiſh'd, that I might be ſure to know what Ingredients I employ'd, and ſhew their effects as well before conjunction as after it. I took then Spirit of Salt, and Spirit of fermented or rather putrified Urine; and having put a ſeal'd Weather-glaſs into an open Veſſel, where one of them was pour'd in, I put the other by degrees to it, and obſerv'd, that, as upon their mingling they made a great noiſe with many bubbles, ſo in this conflict they loſt their former coldneſs, and impell'd up the Spirit of Wine in the ſeal'd Thermoſcope: Then ſlowly evaporating the ſuperfluous moiſture, I obtained

tained a fine ſort of Sal Armoniac for the moſt part figur'd not unlike the other, when being diſſolv'd and filtrated, it is warily coagulated. This new Salt being gently dry'd I put into a wide Glaſs of water, wherein I had before plac'd a ſeal'd Weather-glaſs, that the included Spirit might acquire the temper of the ambient Liquor, and having ſtirr'd this Salt in the water, though I took it then off the mantle-tree of a Chimney that had had fire in it divers hours before, it did, as I expected, make the tinged Spirit haſtily ſubſide and fall conſiderably low.

EXPER. IV.

SInce if two bodies upon their mixture acquire a greater degree of Cold than either of them had before there is a production of this additional degree of that Quality, it will

will be proper to add on this occasion the ensuing Experiment.

We took a competent quantity of acid spirit distill'd from Roch-allom, (that, though rectifi'd, was but weak,) which, in the spirit of that salt, is not strange. Of this we put into a wide mouth'd Glass (that was not great) more than was sufficient to cover the globulous part of a good seal'd Thermoscope, and then suffering the instrument to stay a pretty while in the liquor, that the Spirit of wine might be cool'd as much as the ambient was, we put in little by little some volatile salt sublimed from Sal Armoniac and a fixt *Alcali*, and notwithstanding the very numerous (but not great) bubbles, and the noise and froath that were produced, as is usual upon the reaction of Acids and Alcalys, the tincted spirit in the Weather-glass, after having continued a good while at a stand, began a little to descend, and continued (though but very slowly) to do so, till the spirit of Allom was glutted with

with the volatile ſalt; and this deſcent of the tincted liquor in the Inſtrument being meaſur'd, appear'd to be about an inch (for it manifeſtly exceeded ſeven eighths.) By comparing this Experiment with the firſt part of the foregoing, we may gather, that when Volatile and Urinous Salts or Spirits (for the ſaline particles appear ſometimes in a dry and ſometimes in a liquid form) tumultuate upon their being mixt with Acids, neither the Heat nor the Cold that enſues is produc'd by a Conflict with the Acids preciſely as it is Acid, ſince we have ſeen that an urinous ſpirit produc'd an actual Heat with ſpirit of Salt, and the diſtill'd Salt of Sal Armoniac, which is alſo Urinous, with the acid ſpirit of Roch-Allom produces not a true effervеſcence, but a manifeſt Coldneſs: As the ſame Salt alſo did in a Trial of another ſort, which was this.

EX-

EXPER. V.

WE took one part of Oyl of Vitriol, and ſhaking it into twelve parts of water we made a mixture, that at firſt was ſenſibly warm; then ſuffering this to cool, we put a ſufficient quantity of it into a wide mouth'd glaſs, and then we put a good Thermoſcope Hermetically ſeal'd, above whoſe Ball the compounded liquor reached a pretty way. After ſome time had been allowed that the liquor in the Thermometer might acquire the temper of the ambient; we put in by degrees as much volatile Salt of Sal Armoniac as would ſerve to ſatiate the acid ſpirits of the mixture: for, though theſe two made a notable conflict with tumult, noiſe, and froth, yet 'twas but a cold ebullition (if I may ſo ſtile it,) for the ſpirit in the Thermoſcope deſcended about an inch beneath the mark it reſted at, when the ſeeming effervescence began. EX-

EXPER. VI.

'Tis known that Salt-peter being put into common water produces a ſenſible Coldneſs in it, as it alſo does in many other Liquors: But that the ſame Salt put into a Liquor of another Conſtitution may have a quite differing effect, I have convinc'd ſome inquiſitive perſons by mingling eight ounces of fine Salt-peter powder'd with ſix ounces of Oyl of Vitriol: For by that commixture with a Salt that was not only actually, but, as to many other bodies, potentially cold, the Oyl of Vitriol, that was ſenſibly cold before, quickly conceived a conſiderable degree of Heat, whoſe Effects alſo became viſible in the copious Fumes that were emitted by the incaleſcent Mixture.

EX-

EXPER. VII.

THis brings into my mind, that *though* Gunpowder ſeems to be of ſo igneous a nature, that, when 'tis put upon a Coal, it is turn'd preſently into flame capable of promoting the deflagration of the Charcoal, and kindling divers bodies it meets with in its way; *yet* if ſome ounces of Gunpowder reduced to powder be thrown into four or five times as much water, it will very manifeſtly impart a Coldneſs to it, as experience made *with*, as well as *without*, a ſeal'd Thermoſcope has aſſured me.

This and the foregoing Experiment do readily ſuggeſt an Inquiry into the nature of the Coldneſs, which Philoſophers are wont to oppoſe to that which immediately and upon the firſt contact affect the organs of ſenſe, and which therefore they call Actual or Formal.

The

The ſucceſs of this Experiment upon a ſecond trial ſerv'd to confirm it, which is the more ſtrange, becauſe I have found, that a ſmall quantity of Oyl of Vitriol, not beforehand mingled with water, would produce a notable heat in its conflict with a ſmall portion of juſt ſuch Salt as I employed before (both the parcels having been, if I well remember, taken out of the ſame Glaſs.) And this heat did upon trial, made with the former Thermoſcope, make the tincted Spirit aſcend much further than the lately recited Experiment made it ſubſide.

A DIGRESSION ABOUT POTENTIAL COLDNESS.

Potential Coldneſs has been generally lookt upon, and that partly perhaps upon the ſcore of its very name, as ſo abſtruſe a Quality, that 'tis not onely rational but neceſſary to derive it from the *ſubſtantial Forms* of bodies. But I confeſs I ſee no neceſſity of believing it not to be referrable to Mechanical Principles. For as to the chief Inſtances of Potential Coldneſs, which are taken from the effects of ſome Medicines and aliments in the bodies of men, it may be ſaid without improbability, that the produced Refrigeration proceeds chiefly from this, that the potentially cold

cold body is made up of Corpuſcles of ſuch ſize, ſhape, &c. that being reſolved and disjoined by the Menſtruum of the ſtomach, or the fluids it may elſewhere meet with, they do ſo aſſociate themſelves with the ſmall parts of the blood and other liquors, as, by clogging them or otherwiſe, to leſſen their wonted agitation, and perhaps make them act in a peculiar way as well as leſs briskly on the nervous and fibrous parts; and the perception of this Imminution (and perhaps change) of motion in the organs of feeling is that, which, being referr'd to the body that produces it, we call its *Potential* Coldneſs. Which Quality appears by this account to be, as I was ſaying before, but a Relative thing, and is wont to require the diffuſion or diſperſion of the ſmall parts of the Corpuſcles of the Agent, and their mingling themſelves with the liquors or the ſmall parts of the body they are to refrigerate. And therefore, if it be granted, that

in Agues there is ſome morbifick matter of a viſcous or not eaſily diſſipable texture, that is harbor'd in ſome part of the body, and requires ſuch a time to be made fluid and reſolvable; the Cold Fits of Agues need not be ſo much admired as they uſually are; ſince, though juſt before the Fit the ſame parcel of matter that is to produce it were actually in the body, yet it was not by reaſon of its clammineſs actually reſolved into ſmall parts, and mingled with thoſe of the bloud, and conſequently could not make ſuch a change in the motion of that liquor as is felt in the *Cold Fit* of an Ague; (for, of the further Change that occaſions the *Hot Fit*, I am not here to ſpeak) And in ſome other Diſeaſes a ſmall quantity of matter, being reſolved into minute parts, may be able to produce a great ſenſe of Coldneſs in ſome part of a body, which by reaſon of the ſtructure of that part may be peculiarly diſpoſed to be affected thereby; as

I have known Hypochondriack and Hysterical women complain of great Degrees of Coldness, that would suddenly invade some particular part, chiefly of the Head or Back, and be for a good while troublesome there. And that, if a frigorific vapour or matter be exceeding subtile, an inconsiderable Quantity of it being dispersed through the bloud may suffice to produce a notable Refrigeration, I have learnt by Inquiry into the Effects of some Poysons; and 'tis not very material, whether the Poyson, generally speaking, be cold or hot, if it meet with a body dispos'd to have those affections that pass for cold ones produced in it. For I have made a Chymical Liquor, that was penetrant and fiery enough to the Taste, and had acquired a Subtlety and briskness from Distillation, with which I could almost in a trice, giving it but in the quantity of about a drop, cast an *Animal* into that which appear'd a sleep, and the like

Liquor, in a not much greater quantity, being, by I know not whose mistake, apply'd to the aking Tooth of a very Ingenious Person, did presently, as he soon after told me, give him an universal Refrigeration, and trembling, worse than the cold Paroxisme of a Quartane. And though Scorpions do sometimes cause, by their sting, violent Heats in the parts they hurt, yet sometimes also the quite contrary happens, and their Poyson proves, in a high degree, potentially cold; as may be learnt from the two following Observations recorded by eminent Physicians.* *Famulum habui,* (saith *Benivenius*) *qui à Scorpione ictus, tam subito ac tam frigido sudore toto corpore perfusus est, ut algentissimâ nive atque glacie sese opprimi quereretur. Verum cùm algenti illi solam Theriacam ex vino potentiore exhibuissem, illicò curatus est:* Thus far he: To whose Narrative I adde this of *Amatus Lusitanus.*

* *Beniven. cap. 36. Aditorum apud Schenk. Lib. 7. de venen. Observ. 24.*

Vir

Vir qui à Scorpione in manus digito punctus fuit, multum dolebat, & refrigeratus totus contremebat, & per corpus dolores, cute totâ quaſi acu punctâ, formicantes patiebatur, &c. Cent. 6. Obſerv.

I cannot now ſtay to enquire, Whether there may not be in theſe great Refrigerations, made by ſo ſmall a quantity of Poyſon, ſome ſmall Concretions or Coagulations made of the minute particles of the bloud into little clots, leſs agile and more unwieldy than they were when they moved ſeparately: which may be illuſtrated by the little Curdlings that may be made of the parts of Milk by a very ſmall proportion of Runnet or ſome acid liquor, and the little coagulations made of the Spirit of Wine by that of Urine: Nor will I now enquire, whether, beſides the retardment of the motion of the bloud, ſome poyſons and other analogous Agents may not give the motion of it a new modification, (as if ſome Corpuſcles that uſually are

more whirl'd or brandish'd be put into a more direct Motion) that may give it a peculiar kind of grating or other action upon the nervous and fibrous parts of the body. These, I say, and other suspicions that have sometimes come into my thoughts, I must not stay to examine; but shall now rather offer to Consideration, Whether, since some parts of the humane body are very differing from others in their structure and internal Constitution; and since also some Agents may abound in Corpuscles of differing shapes, bulks, and motions, the same Medicine may not in reference to the same humane body be potentially cold or potentially hot, according as 'tis applied; or perhaps may, upon one or both of the accounts newly mentioned, be cold in reference to one part of the body, and hot in reference to the other. And these effects need not be always ascrib'd to the meer and immediate action of the Corpuscles of the Medicine, but some-

ſometimes to the new Quality they acquire in their Paſſage by aſſociating themſelves with the bloud or other fluids of the body, or to the expulſion of ſome calorific or frigorific Corpuſcles, or to the Diſpoſition they give the part on which they operate, to be more or leſs permeated and agitated than before by ſome ſubtile æthereal matter, or other Efficients of Heat or Cold. Some of theſe Conjectures about the Relative Nature of Potentially cold bodies, may be either confirmed or illuſtrated by ſuch Inſtances as theſe; that Spirit of Wine being inwardly taken is potentially very hot, and yet being outwardly applied to ſome Burns and ſome hot Tumours does notably abate the Heat of the inflamed parts, though the ſame Spirit applied even outwardly to a tender eye will cauſe a great and dolorous agitation in it. And Camphire, which in the Doſe of leſs than a half or perhaps a quarter of a Scruple, has been obſerved to diffuſe

fuſe a Heat through the body, is with ſucceſs externally applied by Phyſicians and Chirurgeons in refrigerating Medicines.

But I leave the further Inquiry into the Operations of Medicines to Phyſicians, who may poſſibly, by what has been ſaid, be aſſiſted to compoſe the differences between ſome famous Writers about the temperament of ſome Medicines, as Mercury, Camphire, &c. which ſome will have to be cold, and others maintain to be hot; and ſhall onely offer by way of confirming, in general, that Potential Coldneſs is onely a Relative Quality, a few Particulars; the firſt whereof is afforded by comparing together the VI. and the VII. Experiment before-going, (which have occaſion'd this Digreſſion about Potential Coldneſs;) ſince by them it ſeems probable, that the ſame thing may have it in reference to one body, and not to another, according to the diſpoſition of the body it operates upon, or that operates

rates upon it. And the Fumes of Lead have been observed sometimes (for I have not found the Effect to succeed always) to arrest the fluidity of Mercury, which change is supposed to be the effect of a Potential Coldness belonging to the Chymists Saturn in reference to fluid Mercury, though it have not that operation on any other liquor that we know of.

And lastly, (for I would not be too prolix) though Nitre and Sal Armoniac be both apart and joyntly Cold in reference to Water, and though, however Nitre be throughly melted in a Crucible, it will not take fire of it self, yet if, whilst it is in Fusion, you shall by degrees cast on it some powder'd Sal Armoniac, it will take fire and flash vehemently, almost as if Sulphur had been injected.

But

But our Excurſion has, I fear, laſted too long, and therefore I ſhall preſently re-enter into the way, and proceed to ſet down ſome Trials about Cold.

EX-

EXPER. VIII.

IN the *first* Experiment we observed, that upon the pouring of water upon Sal Armoniac there ensued an intense degree of Cold, and we have elsewhere recited, that the like effect was produc'd by putting, instead of common water, Oyl of Vitriol to Sal Armoniac; but now, to shew further, what influence Motion and Texture may have upon such Trials, it may not be amiss to adde the following Experiment: To twelve ounces of Sal Armoniac we put by degrees an equal weight of water, and whilst the Liquor was dissolving the Salt, and by that action producing a great Coldness, we warily pour'd in twelve ounces also of good Oyl of Vitriol; of which new mixture the event was, that a notable degree of Heat was quickly produced in the Glass wherein the Ingredients were confounded, as unlikely as it seemed, that, whereas each

each of the two Liquors is wont with Sal Armoniac to produce an intense Cold, both of them acting on it together should produce the contrary Quality. But the reason I had to expect the success, I met with, was this, that 'twas probable the Heat arising from the mixture of the two Liquors would overpower the Coldness produceable by the operation of either, or both, of them upon the Salt.

FINIS.

EXPER. IX.

IN moſt of the Experiments that we have hitherto propoſed, *Cold* is wont to be *regularly* produc'd in a Mechanical way; but I ſhall now adde, that in ſome ſort of Trials I found that the Event was *varied* by unobſerv'd Circumſtances; ſo that ſometimes manifeſt Coldneſs would be produced by mixing two Bodies together, which at another time would upon their Congreſs diſcloſe a manifeſt Heat, and ſometimes again, though more rarely, would have but a very faint and remiſs degree of either.

Of this ſort of Experiments, whoſe Events I could not confidently undertake for, I found to be, the diſſolution of Salt of Tartar in Spirit of Vinegar, and of ſome other Salts, that were not acid, in the ſame Menſtruum, and even Spirit of Verdigreaſe (made *per ſe*) though a more

potent Menſtruum than common Spirit of Vinegar, would not *conſtantly* produce near ſuch a heat at the beginning of its operation, as the greatneſs of the ſeeming Effervescence, then excited, would make one expect, as may appear by the following Obſervation tranſcrib'd *verbatim* out of one of my *Adverſaria*.

[Into eight ounces of Spirit of Verdigreaſe (into which we had put a while before a ſtandard-Thermoſcope to acquire the like temper with the Liquor) we put in a wide-mouthed Glaſs two ounces of Salt of Tartar, as faſt as we durſt for fear of making the matter boil over; and though there were a great commotion excited by the action and reaction of the Ingredients, which was attended with a copious froth and a hiſſing noiſe; yet 'twas a pretty while e're the Glaſs was ſenſibly warm on the outſide; but by that time the ſalt was all diſſolv'd, the Liquor in the Thermoſcope appear'd to be impell'd

pell'd up about three inches and an half.]

And yet, if my memory do not much deceive me, I have found, that by mixing Salt of Tartar with another Salt, the Texture of the fixt *Alkali* was so alter'd, that upon the affusion of spirit of Verdigrease, (made without spirit of Vinegar and spirit of Wine,) though there ensued a great conflict with noise and bubbles, yet, instead of an Incalescence, a considerable degree of Coldness was produced.

EXPER. X.

'TIs very probable that further Trials will furnish us with more Instances to shew how the Production of Cold may in some cases be effected, varied, or hinder'd by Mechanical Circumstances that are easily and usually overlook'd. I remember, on this occasion, that though

in the Experiment above recited we obſerv'd, that Oyl of Vitriol and water being firſt ſhaken together, the volatil ſalt of Sal Armoniac being afterwards put to them, produced a ſenſible Coldneſs; yet I found, that if a little Oyl of Vitriol and of the volatile Salt were firſt put together, though ſoon after a conſiderable proportion of water were added, there would be produc'd not a Coldneſs, but a manifeſt degree of Heat, which would impell up the liquor in the Thermoſcope to the height of ſome inches. And I remember too, that though Salt of Tartar will, as we ſhall ſee e're long, grow hot in the water, yet having diſtill'd ſome Salt of Tartar and Cinaber in a ſtrong fire, and put the whole *Caput mortuum* into diſtill'd or Rain-water, it made indeed a hiſſing there as if it had been Quick-lime, but produced no Heat, that I could by feeling perceive. I ſhall adde, that not onely, as we have ſeen already, ſome unheeded Circumſtances may promote

or

or hinder the artificial Production of Cold by particular Agents, but, which will seem more strange, some unobserv'd, and perhaps hardly observable, Indisposition in the Patient may promote or hinder the effects of the grand and Catholick Efficients of Cold, whatever those be. This suspicion I represent as a thing that further experience may possibly countenance, because I have sometimes found, that the degree of the Operation of Cold has been much varied by latent Circumstances, some bodies being more wrought upon, and others less, than was upon very probable grounds expected. And particularly I remember, that though Oyl of Vitriol be one of the firiest liquors that is yet known, and does perform some of the Operations of fire it self, (as we shall elsewhere have occasion to shew) and will thaw Ice sooner than Spirit of Wine or any other liquor, as I have tried; yet having put about a pound or more, by our estimate, of choice rectified

Oyl of Vitriol into a ſtrong Glaſs-Vial proportionable to it, we found, that, except a little that was fluid at the top, it was all congeal'd or coagulated into a maſs like Ice, though the Glaſs ſtood in a Laboratory where a fire was conſtantly kept not far from it, and where Oyl of Vitriol very ſeldom or never has before or ſince been obſerv'd to congeal or coagulate ſo much as in part. And the odneſs of our *Phænomenon* was increas'd by this Circumſtance, that the Maſs continued ſolid a good while after the weather was grown too mild to have ſuch Operations upon Liquors far leſs indiſpos'd to loſe their fluidity by Cold, than even common Oyl of Vitriol is. On the other ſide I remember, that about two years ago, I expos'd ſome Oyl of ſweet Almonds hermetically ſeal'd up in a Glaſs-bubble, to obſerve what Condenſation an intenſe cold could make of it, (for though Cold expands water, it condenſes common oyl;) but the next day I found

found to my wonder, that not onely the oyl remain'd unfrozen by the ſharp froſt it had been expos'd to, but that it had not its tranſparency troubled, though 'tis known, that oyl will be brought to concrete and turn opacous by a far leſs degree of Cold than is requiſite to freeze water; notwithſtanding which this liquor, which was lodged in a glaſs ſo thin, that 'twas blown at the flame of a Lamp, continued fluid and diaphanous in very froſty weather, ſo long till I loſt the expectation of ſeeing it congeal'd or concreted. And this brings into my mind, that though Camphire be, as I formerly noted, reckon'd by many potentially cold, yet we kept ſome oyl of it, of our making, wherein the whole body of the Camphire remain'd, being onely by ſome Nitrous Spirits reduc'd to the form of an Oyl; we kept it, I ſay, in ſuch intenſe degrees of Cold, that would have eaſily frozen water, without finding it to loſe its Tranſ-

parency or its Fluidity.

And here I ſhall put an end to the firſt Section, (containing our Notes about *Cold*) the deſign of which may be not a little promoted by comparing with them the beginning of the enſuing Section. For if it be true, that (as we there ſhew) the nature of *Heat* conſiſts either onely or chiefly in the local motion of the ſmall parts of a body Mechanically modified by certain conditions, of which the principal is the vehemency of the various agitations of thoſe inſenſible parts; and if it be alſo true, as Experience witneſſes it to be, that, when the minute parts of a body are in or arrive at ſuch a ſtate, that they are more ſlowly or faintly agitated than thoſe of our fingers or other organs of feeling, we judge them cold: Theſe two things laid together ſeem plainly enough to argue, that a Privation or Negation of that Local Motion that is requiſite to conſtitute Heat, may ſuffice for the denominating a body Cold, as Cold-

neſs

neſs is a quality of the Object, (which as 'tis perceiv'd by the mind, is alſo an affection of the Sentient:) And therefore an Imminution of ſuch a degree of former motion as is neceſſary to make a body Hot as to ſenſe, and which is ſufficient to the Production of ſenſible Coldneſs, may be Mechanically made, ſince Slowneſs as well as Swiftneſs being a Mode of Local motion is a Mechanical thing: And though its effect, which is Coldneſs, ſeem a Privation or Negation; yet the Cauſe of it may be a poſitive Agent acting Mechanically, by clogging the Agile Calorific Particles, or deadning their motion, or perverting their determination, or by ſome other intelligible way bringing them to a ſtate of Coldneſs as to ſenſe: I ſay Coldneſs as to ſenſe; becauſe as 'tis a Tactile Quality, in the popular acception of it, 'tis relative to our Organs of Feeling; as we ſee that the ſame luke-warm water will appear hot and cold to the ſame mans hands, if, when

when both are plung'd into it, one of them ſhall have been newly held to the fire, and the other be benummed with froſt. And indeed the cuſtom of ſpeaking has introduced an ambiguity into the word *Cold*, which often occaſions miſtakes, not eaſily without much attention and ſometimes circumlocution alſo to be avoided; ſince uſually by Cold is meant that which immediately affects the ſenſory of him that pronounces a body Cold, whereas ſometimes 'tis taken in a more general notion for ſuch a Negation or Imminution of motion, as though it operates not perceivably on our ſenſes, does yet upon other bodies; and ſometimes alſo it is taken (which is perhaps the more Philoſophical ſenſe) for a perception, made in and by the mind, of the alteration produced in the Corporeal Organs by the operation of that, whatever it be, on whoſe account a body is found to be cold.

But

But the Diſcuſſion of theſe Points is here purpoſely omitted, as for other Reaſons, ſo principally becauſe they may be found expreſly handled in a fitter place.

SECT.

SECT. II.

Of the Mechanicall Origine or Production of HEAT.

AFter having dispatched the Instances I had to offer of the Production of Cold, it remains that I also propose some Experiments of *Heat*, which Quality will appear the more likely to be Mechanically producible, if we consider the nature of it, which seems to consist mainly, if not onely, in that Mechanical affection of matter we call Local motion mechanically modified, which modification, as far as I have observed, is made up of three Conditions.

The first of these is, that the agitation of the parts be *vehement*, by which degree or rapidness, the motion proper to bodies that are hot distin-

diſtinguiſhes them from bodies that are barely *fluid*. For theſe, as ſuch, require not near ſo brisk an agitation, as is wont to be neceſſary to make bodies deſerve the name of *hot*. Thus we ſee that the particles of water in its natural (or uſual) ſtate, move ſo calmly, that we do not feel it at all warm, though it could not be a liquor unleſs they were in a reſtleſs motion; but when water comes to be actually hot, the motion does manifeſtly and proportionably appear more vehement, ſince it does not onely briskly ſtrike our organs of feeling, but ordinarily produces ſtore of very ſmall bubbles, and will melt butter or coagulated oyl, caſt upon it, and will afford vapours, that, by the agitation they ſuffer, will be made to aſcend into the air. And if the degree of Heat be ſuch as to make the water boil, then the agitation becomes much more manifeſt by the confus'd motions, and waves, and noiſe, and bubbles, that are excited, and by other obvious

obvious effects and Phænomena of the vehement and tumultuous motion, which is able to throw up visibly into the air great store of Corpuscles, in the form of vapours or smoak. Thus in a heated Iron the vehement agitation of the parts may be easily inferr'd from the motion and hissing noise it imparts to drops of water or spittle that fall upon it. For it makes them hiss and boil, and quickly forces their particles to quit the form of a liquor, and flye into the air in the form of steams. And lastly, Fire, which is the hottest body we know, consists of parts so vehemently agitated, that they perpetually and swiftly flye abroad in swarms, and dissipate or shatter all the combustible bodies they meet with in their way; fire making so fierce a dissolution, and great a dispersion of its own fuel, that we may see whole piles of solid wood (weighing perhaps many hundred pounds) so dissipated in very few hours into flame and smoak, that ostentimes

tentimes there will not be one pound of Aſhes remaining. And this is the firſt Condition required to Heat.

The ſecond is this, that the *determinations be very various*, ſome particles moving towards the right, ſome to the left, hand, ſome directly upwards, ſome downwards, and ſome obliquely, &c. This variety of determinations appears to be in hot bodies both by ſome of the Inſtances newly mention'd, and eſpecially that of flame, which is a body; and by the diffuſion that metals acquire, when they are melted, and by the operations of Heat that are exercis'd by hot bodies upon others, in what poſture or ſcituation ſoever the body to be heated be applied to them. As a thoroughly ignited Coal will appear every way red, and will melt wax, and kindle brimſtone, whether the body be apply'd to the upper or to the lower, or to any other part of the burning Coal. And congruouſly to this Notion, though

air

air and water be mov'd never ſo vehemently, as in high Winds and Cataracts, yet we are not to expect that they ſhould be manifeſtly hot, becauſe the vehemency belongs to the progreſſive motion of the whole body; notwithſtanding which, the parts it conſiſts of may not be near ſo much quickned in their motions made according to other determinations, as to become ſenſibly hot. And this Conſideration may keep it from ſeeming ſtrange, that in ſome caſes, where the whole body, though rapidly moved, tends but one way, 'tis not by that ſwift motion perceived to be made Hot.

Nay, though the agitation be very *various* as well as *vehement*, there is yet a third Condition required to make it Calorific, namely, that the agitated particles, or at leaſt the greateſt number of them, be ſo minute as to be ſingly *inſenſible*. For though a heap of ſand or duſt it ſelf were vehemently and confuſedly agitated by a whirlwind, the bulk of the

the grains or Corpuſcles, would keep their agitation from being properly Heat, though by their numerous ſtrokes upon a man's face, and the brisk commotion of the ſpirits and other ſmall particles that may thence enſue, they may perchance occaſion the production of that Quality.

If ſome attention be employ'd in conſidering the formerly propos'd Notion of the nature of Heat, it may not be difficult to diſcern, that the Mechanical production of it may be divers ways effected. For, excepting in ſome few Anomalous caſes, (wherein the regular courſe of things happens to be over-rul'd,) by whatever ways the *Inſenſible parts* of a body are put into a very *confus'd* and *vehement agitation*, by the ſame ways Heat may be introduc'd into that body: agreeably to which Doctrine, as there are ſeveral Agents and Operations by which this Calorific Motion (if I may ſo call it) may be excited, ſo there may be ſeveral ways of Mechanically producing

Heat, and many Experiments may be reduc'd to almoſt each of them, chance it ſelf having in the Laboratories of Chymiſts afforded divers *Phænomena* referrable to one or other of thoſe Heads. Many of the more familiar Inſtances, applicable to our preſent purpoſe, have been long ſince collected by our juſtly famous *Verulam* in his ſhort, but excellent, Paper *de forma calidi*, wherein (though I do not acquieſce in every thing I meet with there) he ſeems to have been, at leaſt among the Moderns, the Perſon that has firſt handled the Doctrine of *Heat* like an Experimentall Philoſopher. I ſhall therefore decline accumulating a multitude of Inſtances of the Production of Heat, and I ſhall alſo forbear to inſiſt on ſuch known things, as the Incaleſcence obſervable upon the pouring either of Oyl of Vitriol upon Salt of Tartar, (in the making of *Tartarum Vitriolatum*) or of *Aqua fortis* upon Silver or Quickſilver, (in the diſſolution of theſe Metals) but

ſhall

ſhall rather chuſe to mention ſome few Inſtances not ſo notorious as the former, but not unfit by their variety to exemplifie ſeveral of the differing ways of exciting Heat.

And yet I ſhall not decline the mention of the moſt obvious and familiar Inſtance of all, namely the Heat obſerved in Quick-lime upon the affuſion of cold water, becauſe among learned men, and eſpecially Peripateticks, I find cauſes to be aſſign'd that are either juſtly queſtionable or manifeſtly erroneous. For as to what is inculcated by the Schools about the Incaleſcence of a mixture of Quick-lime and water by vertue of a ſuppoſed *antiperiſtaſis* or Invigoration of the internal Heat of the Lime by its being invironed by cold water, I have elſewhere ſhewn, that this is but an Imaginary Cauſe, by delivering upon Experiment (which any man may eaſily make) that, if inſtead of cold water the liquor be poured on very hot, the ebullition of the Lime will not be the

less, but rather the greater: And Oyl of Turpentine, which is a lighter, and is lookt upon as a subtiler liquor than water, though it be poured quite cold on Quick-lime, will not, that I have observed, grow so much as sensibly hot with it.

And now I have mentioned the Incalescence of Lime, which, though an obvious *Phænomenon*, has exercised the wits of divers Philosophers and Chymists, I will adde two or three Observations in order to an Inquiry that may be some other time made into the genuine Causes of it; which are not so easie to be found as many learned men may at first sight imagine. The acute *Helmont* indeed and his followers have ingeniously enough attempted to derive the Heat under consideration from the conflict of some Alcalizate and Acid salts, that are to be found in Quick-lime, and are dissolved, and so set at liberty to fight with one another by the water that slakes the Lime. But though we have some manifest marks of

of an Alcalizate Salt in Lime, yet that it contains also an Acid Salt, has not, that I remember, been proved; and if the emerging of Heat be a sufficient reason to prove a latent acid Salt in Lime, I know not, why I may not inferr, that the like Salt lies conceal'd in other bodies, which the Chymists take to be of the purest or meerest sort of *Alcalys*.

For I have purposely *EXPER. I.* tried, that by putting a pretty quantity of dry Salt of Tartar in the palm of my hand, and wetting it well in cold water, there has been a very sensible Heat produced in the mixture; and when I have made the trial with a more considerable quantity of salt and water in a Viol, the heat proved troublesomely intense, and continued to be at least sensible a good while after.

This Experiment seems to favour the opinion, that the Heat produced in Lime whilst 'tis quenching, proceeds from the *Empyreuma*, as the Chymists call it, or impression left

by the violent fire, that was employ'd to reduce the ſtone to Lime. But if by *Empyreuma* be meant a bare impreſſion made by the fire, 'twill be more requiſite than eaſie, to declare intelligibly, in what that impreſſion conſiſts, and how it operates to produce ſuch conſiderable effects. And if the effect be aſcribed to ſwarms of Atomes of fire, that remain adherent to the ſubſtance of the Lime, and are ſet at liberty to flye away by the liquor, which ſeems to be argued by the ſlaking of Lime without water, if it be for ſome time left in the air, whereby the Atomes of fire get opportunity to flye away by little and little: If this, I ſay, be alledged, I will not deny but there may be a ſenſe, (which I cannot explicate in few words) wherein the Cooperation of a ſubſtantial *Effluvium*, for ſo I call it, of the fire, may be admitted in giving an account of our *Phænomenon*. But the Cauſe formerly aſſigned, as 'tis crudely propoſed, leaves in my mind ſome

ſome Scruples. For 'tis not ſo eaſie to apprehend, that ſuch light and minute bodies as thoſe of fire are ſuppoſed, ſhould be ſo long detained as by this Hypotheſis they muſt be allowed to be, in Quick-lime, kept in well-ſtopt veſſels, from getting out of ſo laxe and porous a body as Lime, eſpecially ſince we ſee not a great Incaleſcence or Ebullition enſue upon the pouring of water upon *Minium*, or *Crocus Martis per ſe*, though they have been calcined by violent and laſting fires, whoſe Effluviums or Emanations appear to adhere to them by the increaſe of weight, that Lead, if not alſo *Mars*, does manifeſtly receive from the Operation of the Fire. To which I ſhall adde, that, whereas one would think that the igneous Atoms ſhould either flye away, or be extinguiſhed by the ſupervening of water, I know, and elſewhere give account, of an *EXPER. II.* Experiment, in which two Liquors, whereof one was furniſhed

nished me by Nature, did by being several times separated and reconjoyned without additament, at each congress produce a sensible Heat.

EXPER. III. And an Instance of this kind, though not so odd, I purposely sought and found in Salt of Tartar, from which, after it had been once heated by the affusion of water, we abstracted or evaporated the Liquor without violence of fire, till the Salt was again dry; and then putting on water a second time, the same Salt grew hot again in the Vial, and, if I misremember not, it produced this Incalescence the third time, if not the fourth; and might probably have done it oftner, if I had had occasion to prosecute the Experiment. Which seems at least to argue, that the great violence of fire is not necessary to impress what passes for an *Empyreum* upon all calcined bodies that will heat with water.

And

And on this occaſion I ſhall venture to adde, that I have ſometimes doubted, whether the Incaleſcence may not much depend upon the particular Diſpoſition of the calcined body, which being deprived of its former moiſture, and made more porous by the fire, doth by the help of thoſe igneous Effluviums, for the moſt part of a ſaline nature, that are diſperſed through it, and adhere to it, acquire ſuch a Texture, that the water impell'd by its own weight, and the preſſure of the Atmoſphere, is able to get into a multitude of its pores at once, and ſuddenly diſſolve the Igneous and Alcalizate Salt it every where meets with there, and briskly disjoyn the earthy and ſolid particles, that were blended with them; which being exceeding numerous, though each of them perhaps be very minute, and moves but a very little way, yet their multitude makes the confuſed agitation of the whole aggregate of them, and of the particles of the water and ſalt vehement

ment

ment enough to produce a ſenſible Heat; eſpecially if we admit, that there is ſuch a change made in the Pores, as occaſions a great increaſe of this agitation, by the ingreſs and action of ſome ſubtile ethereal matter, from which alone *Monſieur des Cartes* ingeniouſly attempts to derive the Incaleſcence of Lime and water, as well as that of metals diſſolved in corroſive Liquors; though as to the *Phænomena* we have been conſidering, there ſeems at leaſt to concur a peculiar diſpoſition of body, wherein Heat is to be produced to do one or both of theſe two things, namely, to retain good ſtore of the igneous *Effluvia*, and to be, by their adheſion or ſome other operation of the fire, reduced to ſuch a Texture of its component Particles, as to be fit to have them eaſily penetrated, and briskly as well as copiouſly diſſipated, by invading water. And this Conjecture (for I propoſe it as no other) ſeems favour'd by divers *Phænomena*, ſome whereof I ſhall now

now annex. For here it may be obſerved, that both the diſſolved Salt of Tartar lately mentioned, and the artificial Liquor that grows hot with the natural, reacquires that Diſpoſition to Incaleſcence upon a bare Conſtipation or cloſer Texture of the parts from the ſuperfluous moiſture they were drowned in before: The Heat that brought them to this Texture having been ſo gentle, that 'tis no way likely that the igneous Exhalations could themſelves produce ſuch a Heat, or at leaſt that they ſhould adhere in ſuch numbers as muſt be requiſite to ſuch an effect, unleſs the Texture of the Salt of Tartar (or other body) did peculiarly diſpoſe it to detain them; ſince I have found by Trial,

that Sal Armoniac diſ- *EXPER. IV.*
ſolv'd in water, though
boiled up with a briſker fire to a dry ſalt, would, upon its being again diſſolved in water, not produce any Heat, but a very conſiderable degree of Cold. I ſhall adde, that though

though one would expect a great Cognation between the particles of Fire adhering to Quick-Lime, and those of high rectified Spirit of Wine, which is of so igneous a nature, as to be totally inflammable; yet I have not found, that the affusion of Alkaol of Wine upon Quick-Lime, would produce any sensible Incalescence, or any visible dissolution or dissipation of the Lime, as common water would have done, though it seemed to be greedily enough soaked in by the lumps of Lime. And I further tried, that, if on this Lime so drenched I poured cold water, there insued no manifest Heat, nor did I so much as find the lump swelled, and thereby broken, till some hours after; which seems to argue, that the Texture of the Lime was such, as to admit the particles of the Spirit of Wine into some of its pores, which were either larger or more congruous, without admitting it into the most numerous ones, whereinto the Liquor must

muſt be received, to be able ſuddenly to diſſipate the Corpuſcles of Lime into their minuter particles, into which (Corpuſcles) it ſeems that the change that the aqueous particles received by aſſociating with the ſpirituous ones, made them far leſs fit to penetrate and move briskly there, than if they had enter'd alone.

I made alſo an Experiment that ſeems to favour our Conjecture, by ſhewing how much the Diſpoſition of Lime to Incaleſcence may depend upon an idoneous Texture, and the Experiment, as I find it regiſtred in one of my Memorials, is this.

EXPER. V.

[UPon Quick-lime we put in a Retort as much moderately ſtrong Spirit of Wine as would drench it, and ſwim a pretty way above it; and then diſtilling with a gentle

gentle fire, we drew off ſome Spirit of Wine much ſtronger than that which had been put on, and then the Phlegm following it, the fire was increas'd, which brought over a good deal of phlegmatic ſtrengthleſs Liquor; by which one would have thought that the Quick-lime had been ſlaked; but when the remaining matter had been taken out of the Retort, and ſuffer'd to cool, it appear'd to have a fiery diſpoſition that it had not before. For if any lump of it as big as a Nutmeg or an Almond was caſt into the water, it would hiſs as if a coal of fire had been plunged into the Liquor, which was ſoon thereby ſenſibly heated. Nay, having kept divers lumps of this prepared *Calx* well cover'd from the air for divers weeks, to try whether it would retain this property, I found, as I expected, that the *Calx* operated after the ſame manner, if not more powerfully. For ſometimes, eſpecially when 'twas reduced to ſmall pieces, it would upon its

its coming into the water make ſuch a brisk noiſe, as might almoſt paſs for a kind of Exploſion.]

Theſe *Phænomena* ſeem to argue, that the Diſpoſition that Lime has to grow hot with water, depends much on ſome peculiar Texture, ſince the aqueous parts, that one would think capable of quenching all or moſt of the Atomes of Fire that are ſuppoſed to adhere to Quick-lime, did not near ſo much weaken the diſpoſition of it to Incaleſcence, as the acceſſion of the ſpirituous Corpuſcles and their Contexture, with thoſe of the Lime, increaſed that igneous Diſpoſition. And that there might intervene ſuch an aſſociation, ſeems to me the more probable, not onely becauſe much of the diſtill'd Liquor was as phlegmatick, as if it had been robb'd of its more active parts, but becauſe I have ſometimes had Spirit of Wine come over with Quick-lime not in unobſerved ſteams, but white fumes. To which I ſhall adde, that, beſides that the Taſte, and perhaps Odour

Odour of the Spirit of Wine, is often manifeſtly changed by a well-made Diſtillation from Quick-lime; I have ſometimes found that Liquor to give the Lime a kind of Alcalizat penetrancy, not to ſay fierineſs of Taſte, that was very brisk and remarkable. But I will not undertake, that every Experimenter, nor I my ſelf, ſhall always make trials of this kind with the ſame ſucceſs that I had in thoſe above recited, in regard that I have found Quick-limes to differ much, not onely according to the degree of their Calcination, and to their Recentneſs, but alſo, and that eſpecially, according to the differing natures of the ſtones and other bodies calcined. Which Obſervation engages me the more to propoſe what hath been hitherto deliver'd about Quick-lime, as onely Narratives and a Conjecture; which I now perceive has detain'd us ſo long, that I am oblig'd to haſten to the remaining Experiments, and to be the more ſuccinct in delivering them.

EX-

EXPER. VI.

AND it will be convenient to begin with an inſtance or two of the Production of Heat, wherein there appears not to intervene any thing in the part of the Agent or Patient but Local Motion, and the natural Effects of it. And as to this ſort of Experiments, a little attention and reflection may make ſome familiar *Phænomenon* appoſite to our preſent purpoſe. When, for example, a Smith does haſtily hammer a Nail or ſuch like piece of iron, the hammer'd metal will grow exceeding hot, and yet there appears not any thing to make it ſo, ſave the forcible motion of the hammer which impreſſes a vehement and variouſly determin'd agitation of the ſmall parts of the Iron; which being a cold body before, by that ſuperinduc'd commotion of its ſmall parts, becomes in divers ſenſes hot; firſt in a

more *lax acceptation* of the word in reference to ſome other bodies, in reſpect of whom 'twas cold before, and then *ſenſibly hot*; becauſe this newly gain'd agitation ſurpaſſes that of the parts of our fingers. And in this Inſtance 'tis not to be overlookt, that oftentimes neither the hammer, *by* which, nor the anvil, *on* which a *cold piece of Iron* is forged, (for all iron does not require precedent ignition to make it obey the hammer) continue cold, after the operation is ended; which ſhews, that the Heat acquir'd by the forged piece of iron was not communicated by the Hammer or Anvil as Heat, but produc'd in it by motion, which was great enough to put ſo ſmall a body as the piece of iron into a ſtrong and confus'd motion of its parts without being able to have the like operation upon ſo much greater maſſes of metal, as the Hammer and the Anvil; though if the percuſſions were often and nimbly renewed, and the Hammer were but ſmall,

this

this alſo might be heated, (though not ſo ſoon nor ſo much as the iron;) by which one may alſo take notice, that 'tis not neceſſary, a body ſhould be it ſelf hot, to be calorific. And now I ſpeak of ſtriking an iron with a Hammer, I am put in mind of an Obſervation that *ſeems* to contradict, but does *indeed* confirm, our Theory: Namely, that, if a ſomewhat large nail be driven by a hammer into a plank or piece of wood, it will receive divers ſtrokes on the head before it grow hot; but when 'tis driven to the head, ſo that it can go no further, a few ſtrokes will ſuffice to give it a conſiderable Heat; for whilſt, at every blow of the hammer, the nail enters further and further into the wood, the motion that is produc'd is chiefly progreſſive, and is of the whole nail tending one way; whereas, when that motion is ſtopt, then the impulſe given by the ſtroke being unable either to drive the nail further on, or deſtroy its intireneſs, muſt be ſpent in making a

various vehement and inteſtine commotion of the parts among themſelves, and in ſuch an one we formerly obſerv'd the nature of Heat to conſiſt.

EXPER. VII.

IN the foregoing Experiment the brisk agitation of the parts of a heated iron was made ſenſible to the *touch*; I ſhall now adde one of the attempts, that I remember I made to render it diſcoverable to the *eye* it ſelf. In order to this, and that I might alſo ſhew, that not onely a ſenſible but an intenſe degree of heat may be produc'd in a piece of cold iron by Local Motion, I caus'd a bar of that metal to be nimbly hammer'd by two or three luſty men accuſtom'd to manage that Inſtrument; and theſe ſtriking with as much force, and as little intermiſſion as they could upon the iron, ſoon brought it to that degree of Heat, that

that not onely 'twas a great deal too hot to be ſafely touched, but probably would, according to my deſign, have kindled Gunpowder, if that which I was fain to make uſe of had been of the beſt ſort: For, to the wonder of the by-ſtanders, the iron kindled the Sulphur of many of the grains of the corns of powder, and made them turn blue, though I do not well remember, that it made any of them go off.

EXPER. VIII.

BEſides the effects of manifeſt and violent Percuſſions, ſuch as thoſe we have been taking notice of to be made with a hammer, there are among *Phænomena* obvious enough, ſome that ſhew the Producibleneſs of Heat even in cold iron, by cauſing an inteſtine commotion of its parts: For we find, that, if a piece of iron of a convenient ſhape and bulk be nimbly filed with a large rough File,

a conſiderable degree of Heat will be quickly excited in thoſe parts of the iron where the File paſſes to and fro, the many prominent parts of the Inſtrument giving a multitude of ſtrokes or puſhes to the parts of the iron that happen to ſtand in their way, and thereby making them put the neighbouring parts into a brisk and confus'd motion, and ſo into a ſtate of Heat. Nor can it be well objected, that upon this account the File it ſelf ought to grow as hot as the iron, which yet it will not do; ſince, to omit other anſwers, the whole body of the File being moved to and fro, the ſame parts, that touch the iron this moment, paſs off the next, and beſides have leaſure to cool themſelves by communicating their newly received Agitation to the air before they are brought to grate again upon the iron, which, being ſuppoſed to be held immoveable, receives almoſt perpetual ſhakes in the ſame place.

We find also, that Attrition, if it be any thing vehement, is wont to produce Heat in the solidest bodies; as when the blade of a Knife being nimbly whetted grows presently hot. And if having taken a brass Nail, and driven it as far as you can to the end of the stick, to keep it fast and gain a handle, you then strongly rub the head to and fro against the floor or a plank of wood, you may quickly find it to have acquired a Heat intense enough to offend, if not burn ones fingers. And I remember, that going once in exceeding hot weather in a Coach, which for certain reasons we caus'd to be driven very fast, the attrition of the Nave of the Wheel against the Axel-tree was so vehement as oblig'd us to light out of the Coach to seek for water, to cool the over-chafed parts, and stop the growing mischief the excessive Heat had begun to do.

The vulgar Experiment of striking fire with a Flint and Steel sufficiently declares, what a heat in a trice

may be produc'd in cold bodies by Percuſſion, or Colliſion; the later of which ſeems but mutual Percuſſion.

But Inſtances of the ſame ſort with the reſt mention'd in this VI. Experiment being obvious enough, I ſhall forbear to multiply and inſiſt on them.

EXPER. IX.

FOr the ſake of thoſe that think the Attrition of contiguous air is neceſſary to the Production of manifeſt Heat, I thought among other things of the following Experiment, and made Trial of it.

We took ſome hard black Pitch, and having in a Baſon, Poringer, or ſome ſuch Veſſel, placed it a convenient diſtance under water, we caſt on it with a good Burning-glaſs the Sun-beams in ſuch a manner, that notwithſtanding the Refraction that they ſuffer'd in the paſſage through the

the interpoſed water, the *Focus* fell upon the Pitch, wherein it would produce ſometimes bubbles, ſometimes ſmoak, and quickly communicated a degree of Heat capable to make Pitch melt, if not alſo to boil.

EXPER. X.

THough the firſt and ſecond Experiments of Section I. ſhew, that a conſiderable degree of Cold is produc'd by the diſſolution of Sal Armoniac in common water; yet by an additament, though but ſingle, the Texture of it may be ſo alter'd, that, inſtead of Cold, a notable degree of Heat will be produced, if it be diſſolved in that Liquor. For the manifeſtation of which we devis'd the following Experiment.

We took Quick-lime, and ſlaked it in common cold water, that all the igneous or other particles, to which its power of heating that Liquor

quor is aſcrib'd, might be extracted and imbib'd, and ſo the *Calx* freed from them; then on the remaining powder freſh water was often pour'd, that all adhering reliques of Salt might be waſh'd off. After this, the thus dulcified *Calx*, being again well dried, was mingled with an equal weight of powder'd Sal Armoniac, and having with a ſtrong fire melted the maſs, the mixture was poured out; and being afterwards beaten to powder, having given it a competent time to grow cold, we put two or three ounces of it into a wide-mouthed Glaſs, and pouring water upon it, within about a minute of an hour the mixture grew warm, and quickly attain'd ſo intenſe a Heat, that I could not hold the Glaſs in my hand. And though this Heat did not long laſt at the ſame height, it continued to be very ſenſible for a conſiderable time after.

EX-

EXPER. XI.

TO confirm this Experiment by a notable variation; we took finely powder'd Sal Armoniac, and filings or ſcales of Steel, and when they were very diligently mixt (for that Circumſtance ought to be obſerv'd) we caus'd them to be gradually ſublim'd in a glaſs veſſel, giving a ſmart fire towards the latter end. By this Operation ſo little of the mixture aſcended, that, as we deſired, far the greateſt part of the Sal Armoniac ſtaid at the bottom with the metal; then taking out the *Caput mortuum*, I gave it time throughly to cool, but in a Glaſs well ſtopt, that it might not imbibe the moiſture of the Air, (as it is very apt to do.) And laſtly, though the Filings of Steel, as well as the Sal Armoniac, were bodies actually cold, and ſo might be thought likely to increaſe, not check,

check, the coldneſs wont to be produced in water by that Salt; yet putting the mixture into common water, there enſued, as we expected, an intenſe degree of Heat. And I remember, that having ſublim'd the forementioned Salt in diſtinct Veſſels, with the Filings of Steel, and with Filings of Copper, and for curioſities ſake kept one of the *Caput mortuums* (for I cannot certainly call to mind which of the two it was,) divers moneths, (if I miſtake not, eight or nine,) we at length took it out of the Veſſel, wherein it had been kept carefully ſtopt, and, upon trial, were not deceiv'd in having expected, that all that while the diſpoſition to give cold water a notable degree of Heat was preſerved in it.

EX-

EXPER. XII.

IF Experiments were made after the above recited manner with Sal Armoniac and other mineral bodies than Iron and Copper, 'tis not improbable, that ſome of the emerging *Phænomena* would be found to confirm what has been ſaid of the Intereſt of Texture, (and ſome few other Mechanical Affections) in the Production of *Heat* and *Cold*. Which Conjecture is ſomewhat favoured by the following Trial. Three ounces of Antimony, and an equal weight of Sal Armoniac being diligently powder'd and mixt, were by degrees of fire ſublimed in a Glaſs-veſſel, by which Operation we obtain'd three differing Subſtances, which we cauſed to be ſeparately powder'd, when they were taken out of the Subliming Glaſs, leſt the air or time ſhould make any change in them; and having before put the ball of a good

good seal'd Weather-glass for a while into water, that the Spirit of Wine might be brought to the temper of the external Liquor, we put on a convenient quantity of the powder'd *Caput mortuum*, which amounted to two ounces, and seemed to be little other than Antimony, which accordingly did scarce sensibly raise the Spirit of Wine in the Thermoscope, though that were a tender one. Then laying aside that water, and putting the Instrument into fresh, of the same temper, we put to it a very yellow Sublimate, that ascended higher than the other parts, and seemed to consist of the more sulphureous flowers of the Antimony, with a mixture of the more volatile parts of the Sal Armoniac. And this Substance made the tinged Spirit in the Thermoscope descend very slowly about a quarter of an inch; but when the Instrument was put into fresh water of the same temper, and we had put in some of the powder of the lower sort of Sublimate,

limate, which was dark coloured, though both the Antimony and Sal Armoniac, it consisted of, had been long exposed to the action of a Subliming Heat; yet the water was thereby speedily and notably cooled, insomuch, that the Spirit of Wine in the Weather-glass hastily descended, and continued to sink, till by our guess it had fallen not much short of three inches. Of these *Phænomena* the Etiology, as some Moderns call the Theory, which proposes the Causes of things, is more easie to be found by a little consideration, than to be made out in few words.

We made also an Experiment like that above recited, by subliming three ounces a piece of Minium and Sal Armoniac; in which Trial we found, that though in the *Caput mortuum*, the Salt had notably wrought upon the *Calx* of Lead, and was in part associated with it, as appear'd by the whiteness of the said *Caput mortuum*, by its sweetish Taste, and by

by the weight (which exceeded four drams that of all the *Minium*;) yet a convenient quantity of this powder'd mixture being put into water, wherein the former Weather-glass had been kept a while, the tincted Spirit of Wine was not manifestly either raised or depress't. And when in another Glass we prosecuted the Trial with the Sal Armoniac that had been sublimed from the *Minium*, it did indeed make the Spirit of Wine descend, but scarce a quarter so much as it had been made to fall by the lately mention'd Sublimate of Sal Armoniac and Antimony.

EX-

EXPER. XIII.

'Tis known that many learned men, beſides ſeveral Chymical Writers, aſcribe the Incaleſcences, that are met with in the diſſolution of Metals, to a conflict ariſing from a certain Antipathy or Hoſtility, which they ſuppoſe between the conflicting bodies, and particularly between the Acid Salt of the one, and the Alcalizate Salt, whether fixt or volatile, of the other. But ſince this Doctrine ſuppoſes a hatred between Inanimate bodies, in which 'tis hard to conceive, how there can be any true paſſions, and does not intelligibly declare, by what means their ſuppos'd Hoſtility produces Heat; 'tis not likely, that, for theſe and ſome other Reaſons, Inquiſitive Naturaliſts will eaſily acquieſce in it. And on the other ſide it may be conſider'd, whether it be not more probable, that Heats, ſuddenly produ-

ced in mixtures, proceed *either* from a very quick and copious diffusion of the parts of one body through those of another, whereby both are confusedly tumbled and put into a calorific motion; *or* from this, that the parts of the dissolved body come to be every way in great numbers violently scatter'd; *or* from the fierce and confused shocks or justlings of the Corpuscles of the conflicting bodies, or masses which may be suppos'd to have the motions of their parts differingly modified according to their respective Natures: *Or* from this, that by the plentiful ingress of the Corpuscles of the one into the almost commensurate parts of the other, the motion of some etherial matter that was wont before swiftly to permeate the distinct bodies, comes to be check'd and disturbed, and forced to either brandish or whirl about the parts in a confus'd manner, till it have settled it self a free passage through the new mixture, almost as the Light does thorow divers

vers troubled liquors and vitrified bodies, which at length it makes transparent. But without *here* engaging in a ſolemn examination of the *Hypotheſis* of *Alcali* and *Acidum*, and without determining whether any one, or more of the newly mention'd Mechanical Cauſes, or whether ſome other, that I have not yet named, is to be entitled to the effect; it will not be impertinent to propoſe divers Inſtances of the Production of Heat by the Operation of one Agent, *Oyl of Vitriol*, that it may be conſider'd whether it be likely, that this ſingle Agent ſhould upon the ſcore of Antipathy, or that of its being an Acid Menſtruum, be able to produce an intenſe Heat in many bodies of ſo differing natures as are ſome of thoſe that we ſhall have occaſion to name. And now I proceed to the Experiments themſelves.

Take ſome ounces of ſtrong Oyl of Vitriol, and ſhaking it with three or four times its weight of common water, though both the liquors were cold when they were put together, yet their mixture will in a trice grow intenſely hot, and continue conſiderably ſo for a good while. In this caſe it cannot probably be pretended by the Chymiſts, that the Heat ariſes from the conflict of the Acid and Alcalizate Salts abounding in the two liquors, ſince the common water is ſuppos'd an elementary body devoid of all ſalts; and at leaſt, being an inſipid liquor, 'twill ſcarce be thought to have *Alcali* enough to produce by its Reaction ſo intenſe a Heat. That the Heat emergent upon ſuch a mixture may be very great, when the Quantities of the mingled liquors are conſiderably ſo, may be eaſily concluded from one of my Memorials, wherein I find that no more than two ounces of Oyl of Vitriol being poured (but not all at once) into four ounces onely of diſtilled

ſtilled Rain-water, made and kept it manifeſtly warm for a pretty deal above an hour, and during no ſmall part of that time, kept it ſo hot, that 'twas troubleſome to be handled.

EXPER. XIV.

THe former Experiment brings into my mind one that I mention without teaching it in the Hiſtory of Cold, and it appear'd very ſurprizing to thoſe that knew not the ground of it. For having ſometimes merrily propos'd to heat cold liquors with Ice, the undertaking ſeem'd extravagant if not impoſſible, but was eaſily perform'd by taking out of a baſon of cold water, wherein divers fragments of Ice were ſwimming, one or two pieces that I perceived were well drenched with the liquor, and immerſing them ſuddenly into a wide-mouth'd Glaſs wherein ſtrong Oyl of Vitriol had

been put; for this Menſtruum, preſently mingling with the water that adher'd to the ice, produc'd in it a brisk heat, and that ſometimes with a manifeſt ſmoke, which nimbly diſſolved the contiguous parts of Ice, and thoſe the next, and ſo the whole Ice being ſpeedily reduced to water, and the corroſive Menſtruum being by two or three ſhakes well diſperſed through it, and mingled with it, the whole mixture would grow in a trice ſo hot, that ſometimes the Vial that contain'd it, was not to be endured in ones hand.

EX-

EXPER. XV.

NOtwithſtanding the vaſt difference betwixt common water and high rectified Spirit of Wine, whereof men generally take the former for the moſt contrary body to fire, and whereof the Chymiſts take the later to be but a kind of liquid Sulphur, ſince it may preſently be all reduc'd into flame; yet, as I expected, I found upon trial, that Oyl of Vitriol being mingled with pure Spirit of Wine, would as well grow hot, as with common water. Nor does this Experiment always require great quantities of the liquors. For when I took but one ounce of ſtrong Oyl of Vitriol, though I put to it leſs than half an ounce of choice Spirit of Wine, yet thoſe two being lightly ſhaken together, did in a trice conceive ſo brisk a Heat, that they almoſt fill'd the vial with fumes, and made it ſo hot, that I had una-

wares like to have burnt my hand with it before I could lay it aside.

I made the like Trial with the same Corrosive Menstruum, and common *Aqua vitæ* bought at a Strong-water-shop, by the mixture of which Liquors, Heat was produc'd in the Vial that I could not well endure.

The like success I had in an Experiment wherein Oyl of Vitriol was mixt with common Brandy; save that in this the Heat produced seem'd not so intense as in the former Trial, which it self afforded not so fierce a Heat as that which was made with rectified Spirit of Wine.

EX-

EXPER. XVI.

THoſe Chymiſts, who conceive that all the Incaleſcencies of bodies upon their being mixt, proceed from their antipathy or hoſtility, will not perhaps expect, that the parts of the ſame body, (either numerically, or in *ſpecie*, as the Schools phraſe it,) ſhould, and that without manifeſt conflict, grow very hot together. And yet having for trials ſake put two ounces of *Colcothar* ſo ſtrongly calcin'd, that it was burnt almoſt to blackneſs, into a Retort, we poured upon it two ounces of ſtrong Oyl of Engliſh Vitriol, and found, that after about a minute of an hour they began to grow ſo hot, that I could not endure to hold my hand to the bottom of the Veſſel, to which the mixture gave a heat, that continued ſenſible on the outſide for between twenty and thirty minutes.

EX-

EXPER. XVII.

THough I have not obſerv'd any Liquor to equal Oyl of Vitriol in the number of Liquors with which it will grow hot; yet I have not met with any Liquor wherewith it came to a greater Incaleſcence than it frequently enough did with common *Oyl of Turpentine*. For when we cauſed divers ounces of each to be well ſhaken together in a ſtrong veſſel, faſten'd, to prevent miſchief, to the end of a pole or ſtaff; the Ebullition was great and fierce enough to be not undeſervedly admired by the Spectators. And this brings into my mind a pleaſant adventure afforded by theſe Liquors, of each of which, having for the Production of Heat and other purpoſes, caus'd a good bottle full to be put up with other things into a box, and ſent down into the Countrey with a great charge, that

that care ſhould be had of the Glaſſes; the Wagon, in which the box was carried, happen'd by a great jolt, that had almoſt overturn'd it, to be ſo rudely ſhaken, that theſe Glaſſes were both broken, and the Liquors, mingling in the box, made ſuch a noiſe and ſtink, and ſent forth ſuch quantities of ſmoke by the vents, which the fumes had open'd to themſelves, that the Paſſengers with great outcries and much haſte threw themſelves out of the Wagon, for fear of being burnt in it.

The Trials we made with Oyl of Turpentine, when ſtrong Spirit of Nitre was ſubſtituted in the ſtead of Oyl of Vitriol, belong not to this place.

EX-

EXPER. XVIII.

BUt though *Petroleum*, eſpecially when rectified, be, as I have elſewhere noted, a moſt ſubtile Liquor, and the lighteſt I have yet had occaſion to try; yet to ſhew you how much the Incaleſcence of Liquors may depend upon their Texture, I ſhall adde, that having mixt by degrees one ounce of rectified *Petroleum*, with an equal weight of ſtrong Oyl of Vitriol, the former Liquor ſeemed to work upon the Surface of this laſt named, almoſt like a *Menſtruum*, upon a metal, innumerous and ſmall bubbles continually aſcending for a while into the *Oleum Petræ*, which had its colour manifeſtly alter'd and deepen'd by the operation of the ſpirituous parts. But by all the action and re-action of theſe Liquors, there was produced no ſuch ſmoaking and boiling, or intenſe heat, as if Oyl of Turpentine

tine had been employed inſtead of Oyl of Vitriol; the change which was produc'd as to *Qualities* being but a kind of Tepidneſs diſcoverable by the Touch.

Almoſt the like ſucceſs we had in the Conjunction of *Petroleum*, and Spirit of Nitre, a more full account whereof may be elſewhere met with.

In this and the late Trials I did not care to make uſe of Spirit of Salt, becauſe, at leaſt, if it be but ordinarily ſtrong, I found its operation on the Liquors above menti-on'd inconſiderable, (and ſometimes perhaps ſcarce ſenſible) in compariſon of thoſe of Oyl of Vitriol, and in ſome caſes of dephlegm'd Spirit of Nitre.

EX-

EXPER. XIX.

EXperienced Chymiſts will eaſily believe, that 'twere not difficult to multiply Inſtances of Heat producible by Oyl of Vitriol upon ſolid bodies, eſpecially Mineral ones. For 'tis known, that in the uſual preparation of *Vitriolum Martis*, there is a great effervescence excited upon the affuſion of the Oyl of Vitriol upon Filings of Steel, eſpecially if they be well drench'd in common water. And it will ſcarce be doubted, but that, as Oyl of Vitriol will (at leaſt partly) diſſolve a great many both calcin'd and teſtaceous bodies, as I have try'd with Lime, Oyſter-ſhells, &c. ſo it will, during the diſſolution, grow ſenſibly, if not intenſely hot with them, as I found it to do both with thoſe newly named, and others, as Chalk, *Lapis Calaminaris*, &c. with the laſt of which, if the Liquor be ſtrong, it will heat exceedingly.

EX-

EXPER. XX.

WHerefore I will rather take notice of its Operation upon Vegetables, as bodies which corrosive Menstruums have scarce been thought fit to dissolve and grow hot with. To omit then Cherries, and divers Fruits abounding in watery juices, with which, perhaps on that very account, Oyl of Vitriol will grow hot; I shall here take notice, that for trial sake, having mixt a convenient quantity of that Liquor with Raisins of the Sun beaten in a Mortar, the Raisins grew so hot, that, if I misremember not, the Glass that contain'd it had almost burnt my hand.

These kind of Heats may be also produc'd by the mixture of Oyl of Vitriol with divers other Vegetable Substances; but, as far as I have observed, scarce so eminently with any dry body, as with the crumbs of white

white bread, (or even of brown) with a little of which we have ſometimes produced a ſurpriſing degree of Heat with ſtrong or well-dephlegm'd Oyl of Vitriol, which is to be ſuppos'd to have been employed in the foregoing Experiments, and all others mention'd to be made by the help of that Menſtruum in our Papers about Qualities, unleſs it be in any particular caſe otherwiſe declared.

EXPER. XXI.

'Tis as little obſerved that Corroſive Menſtruums are able to work, as ſuch, on the ſoft parts of dead Animals, as on thoſe of Vegetables, and yet I have more than once produced a notable Heat by mixing Oyl of Vitriol with minced fleſh whether roaſted or raw.

EX-

EXPER. XXII.

THough common Sea-ſalt does uſually impart ſome degree, though not an intenſe one, of Coldneſs unto common water, during the act of Diſſolution; yet ſome Trials have informed me, that if it were caſt into a competent quantity of Oyl of Vitriol, there would for the moſt part inſue an Incaleſcence, which yet did not appear to ſucceed ſo regularly, as in moſt of the foregoing Experiments. But that Heat ſhould be produc'd uſually, though not perhaps conſtantly, by the above-named Menſtruum and Salt, ſeems therefore worthy of our notice, becauſe 'tis known to Chymiſts, that common Salt is one main Ingredient of the few that make up common factitious Sal Armoniac, that is wont to be ſold in the Shops. And I have been inform'd, that the excellent Academians of *Florence* have

observed, that Oyl of Vitriol would not grow hot but cold by being put upon Sal Armoniac: Something like which I took notice of in rectified Spirit of Sulphur made *per Campanam*, but found the effect much more considerable, when, according to the Ingenious *Florentine* Experiment, I made the Trial with Oyl of Vitriol; which Liquor having already furnished us with as many *Phænomena* for our present purpose as could be well expected from one Agent, I shall scarce in this Paper about Heat make any farther use of it, but proceed to some other Experiments, wherein it does not intervene.

EX-

EXPER. XXIII.

WE took a good lump of common Sulphur of a convenient ſhape, and having rub'd or chaf'd it well, we found, as we expected, that by this attrition it grew ſenſibly warm; and, That there was an inteſtine agitation, which you know is Local Motion, made by this attrition, did appear not onely by the newly mention'd Heat, whoſe nature conſiſts in motion, and by the antecedent preſſure, which was fit to put the parts into a diſorderly vibration, but alſo by the ſulphureous ſteams, which 'twas eaſie to ſmell by holding the Sulphur to ones noſe, as ſoon as it had been rub'd. Which Experiment, though it may ſeem trivial in it ſelf, may be worth the conſideration of thoſe Chymiſts, who would derive all the Fire and Heat we meet with in ſublunary bodies from Sulphur. For in our caſe

a mass of Sulphur, before its parts were put into a new and brisk motion, was sensibly cold, and as soon as its parts were put into a greater agitation than those of a mans fingers, it grew sensibly hot; which argues, that 'twas not by its bare presence, or any emanative action, (as the Schools speak) that the Sulphur communicated any Heat to my hand; and also that, when 'twas briskly moved, it did impress that Quality, was no more than another solid body, though incombustible as common Glass, would have done, if its parts had been likewise put into an agitation surpassing that of my organs of feeling; so that in our Experiment, Sulphur it self was beholden, for its actual Heat, to Local Motion, produced by external agents in its parts.

EX-

EXPER. XXIV.

WE thought it not amiſs to try, whether when Sal Armoniac, that much infrigidates water, and Quick-lime, which is known to heat it, were by the fire exquiſitely mingled, the mixture would impart to the Liquor a moderate or an intenſe degree of either of thoſe Qualities. In proſecution of which Inquiry we took equal parts of Sal Armoniac and Quick-lime, which we fluxed together, and putting an ounce, by gheſs, of the powder'd mixture into a Vial with a convenient quantity of cold water, we found, that the colliquated maſs did, in about a minute, ſtrike ſo great a heat through the Glaſs upon my hand, that I was glad to remove it haſtily for fear of being ſcorched.

EXPER. XXV.

WE have given ſeveral, and might have given many more, Inſtances of the Incaleſcence of Mixtures, wherein both the Ingredients were Liquors, or at leaſt one of them was a fluid body. But ſometimes Heat may alſo be produc'd by the mixture of two powders; ſince it has been obſerved in the preparation of the Butter or Oyl of Antimony, that, if a ſufficient quantity of beaten Sublimate be very well mingled with powder'd Antimony, the mixture, after it has for a competent time (which varies much according to circumſtances, as the weather, veſſel, place, &c. wherein the Experiment is made) ſtood in the air, would ſometimes grow manifeſtly hot, and now and then ſo intenſely ſo, as to ſend forth copious and fetid fumes almoſt as if it would take fire. There is another Experiment

riment made by the help of Antimony, and a pulveriz'd body, wherein the mixture, after it had been for divers hours expos'd to the air, visibly afforded us mineral Fumes. And to these I could adde more considerable, and perhaps scarce credible, Instances of bodies growing hot without Liquors, if Philanthropy did not forbid me. But to return to our Butter of Antimony, it seems not unfit to be enquired, whether there do not unobservedly intervene an aqueous moisture, which (capable of relaxing the salts, and setting them a work) I therefore suspected might be attracted (as men commonly speak) from the air, since the mixture of the Antimony and the Sublimate is prescribed to be placed in Cellars; and in such we find, that Sublimate, or at least the saline part of it, is resolved *per deliquium*, (as they call it) which is nothing but a solution made by the watery steams wandering in the Air.

EXPER. XXVI.

I Have formerly deliver'd ſome Inſtances of the Incaleſcence produc'd by water in bodies that are readily diſſolv'd in it, as Salt of Tartar and Quick-lime. But one would not lightly expect, that meer water ſhould produce an Incaleſcence in ſolid bodies that are generally granted to be inſoluble in it; and are not wont to be, at leaſt without length of time, viſibly wrought on by it; and yet trial has aſſured me, that a notable Incaleſcence may be produc'd by common water in flower or fine powder of Sulphur, and Filings of Steel or Iron. For when, in Summer time, I caus'd to be mingled a good quantity, (as half a pound or rather a pound of each of the Ingredients) and caus'd them to be throughly drenched with common water, in a convenient quantity whereof they were very well ſtirred

red up and down, and carefully mingled, the mixture would in a ſhort time, perhaps leſs than an hour, grow ſo hot, that the Veſſel that contain'd it could not be ſuffer'd in ones hand; and the Heat was manifeſted to other Senſes than the Touch, by the ſtrong ſulphureous ſtink that invaded the noſe, and the thick ſmoak that aſcended out of the mixture, eſpecially when it was ſtirr'd with a ſtick or ſpattle. Whether the ſucceſs will be the ſame at all times of the year, I do not know, and ſomewhat doubt, ſince I remember not, that I had occaſion to try it in other Seaſons than in Summer, or in Autumn.

EX-

EXPER. XXVII.

IN the Instances that Chymistry is wont to afford us of the Heat produc'd by the action of Menstruums upon other bodies, there intervenes some liquor, properly so call'd, that wets the hands of those that touch it; and there are divers of the more judicious Chymists, that joyn with the generality of the Naturalists in denying, that Quicksilver, which is indeed a fluid body, but not a moist and wetting one in reference to us, will produce Heat by its immediate action on any other body, and particularly on Gold. But though I was long inclinable to their opinion, yet I cannot now be of it, several Trials having assur'd me, that a Mercury, whether afforded by Metals and Minerals, or impregnated by them, may by its preparation be enabled to insinuate it self nimbly into the body

body of Gold, whether calcin'd or crude, and become manifeſtly incaleſcent with it in leſs than two or three minutes of an hour.

EXPER. XXVIII.

SInce we know that ſome natural Salts, and eſpecially Salt-peter, can produce a Coldneſs in the water they are diſſolved in, I thought it might not be impertient to our enquiry into Heat and Cold, and might perhaps alſo contribute ſomewhat to the diſcovery of the Structure of Metals, and the ſalts that corrode them, if Solutions were made of ſome Saliform'd bodies, as Chymiſts call them, that are made up of metalline and ſaline parts, and do ſo abound with the latter, that the whole Concretions are on their account diſſoluble in common water.

Other

Other Experiments of this ſort belonging leſs to this place than to another, I ſhall here onely for example ſake take notice of one that we made upon Quickſilver, which is eſteem'd the coldeſt of Metals. For having by diſtilling from it four times its weight of Oyl of Vitriol, reduc'd it to a powder, which on the account of the adhering Salts of the Menſtruum that it detain'd, was white and gliſtering, we put this powder into a wide-mouth'd Glaſs of water, wherein a ſeal'd Weather-glaſs had been left before it began manifeſtly to heat the water, as appear'd by the quick and conſiderable aſcent of the tincted Spirit of Wine, that continued to riſe upon putting in more of the Magiſtery; which warm event is the more remarkable, becauſe of the obſervation of *Helmont*, that the Salt adhering to the Mercury, corroded in good quantity by Oyl of Vitriol,

if

if it be washed off and coagulated, becomes a kind of Alom.

The event of the former Trial deserves the more notice, because having after the same manner and with the same Weather-glass made an Experiment with common water, and the powder of *Vitriolum Martis*, made with Oyl of Vitriol and the Filings of Steel, the tincted Spirit of Wine was not at all impell'd up as before, but rather, after a while, began to subside, and fell, though very slowly, about a quarter of an inch. The like Experiment being tried with powder'd Sublimate in common water, the liquor in the Thermoscope was scarce at all sensibly either rais'd or depress't, which argued the alteration as to Heat or Cold, to have been either none or very inconsiderable.

Having

Having given warning at the beginning of this Section, that in it I aimed rather at offering various than numerous Experiments about the Production of Heat, I think what has been already deliver'd may allow me to take leave of this Subject without mentioning divers Instances that I could easily adde, but think it fitter at present to omit. For those afforded me by Trials about *Antiperistasis* belong to a Paper on that Subject. Those that might be offer'd about Potential Heat in humane bodies, would perchance be thought but unnecessary after what has been said of Potential Coldness; from which an attentive Considerer may easily gather, what according to our Doctrine is to be said of the contrary Quality. And divers *Phænomena*, which would have been of the most considerable I could have mentioned of the Production of Heat, since

ſince in them that Quality is the moſt exalted, I reſerve for the Title of *Combuſtibleneſs* and *Incombuſtibility*, having already ſuffer'd this Collection (or rather Chaos) of Particulars *about the Production of Heat* to ſwell to too great a bulk.

FINIS.

EXPERIMENTS,
AND
OBSERVATIONS,
About the
Mechanical Production
OF
TASTS.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

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EXPERIMENTS,
AND
OBSERVATIONS,
About the
Mechanical Production
OF
TASTS.

TO make out the Mechanical Origine or Production of *Sapors*, as far as is neceſſary for my preſent purpoſe, 'twill be expedient to premiſe in general, that, according to our notion of Taſts, they may depend upon the bigneſs, figure and motion of the ſaporifick corpuſcles, conſidered ſeparately, and as the affections of ſingle and very minute particles of matter; or elſe in a ſtate of conjunction, as two or more

of these affections, and the particles they belong to, may be combined or associated, either among themselves, or with other particles, that were not saporous before. And as these Coalitions and other Associations come to be diversified; so the Tasts, resulting from them, will be altered or destroyed.

But, to handle these distinctly and fully, were a task not onely too difficult and long, but improper in this place, where I pretend to deliver not Speculations, but matters of Fact: in setting down whereof nevertheless, to avoid too much confusion, I am content, where I can doe it readily and conveniently, in some of my Trials, to couch such references as may best point at those Heads, whence the Mechanical explications may be derived, and consequently our Doctrine confirmed.

By Tast considered as belonging to the Object, (under which Notion I here treat of it,) I mean that quality, or whatever else it be, which enables

bles a body by its operation, to produce in us that ſenſation, which we feel or perceive when we ſay we *taſt*.

That this ſomething, whether you will call it a quality, or whatever elſe it be that makes or denominates an object *ſaporous*, or rather (if I may be allowed a barbarous term) *ſaporifick*, may ſo depend upon the ſhape, ſize, motion, and other Mechanical affections of the ſmall parts of the taſted body, and reſult from the aſſociation of two or more of them, not excluding their congruity or incongruity to the organs of Taſting, may be made probable by the following Inſtances.

EXPER. I.

To divide a Body, almoſt inſipid, into two Bodies of very ſtrong and very differing Taſts.

'TIS obſerved, that Salt-peter refined, and by that purification freed from the Sea-ſalt that is wont to be mingled with it, does rather cool the tongue, than make any great ſaporifick impreſſions on it. And though I will not ſay, that it is, as ſome have thought, an inſipid body; yet the bitteriſhneſs, which ſeems to be its proper taſt, is but very faint and languid. And yet this almoſt inſipid body, being diſtilled by the way of Inflammation, (which I elſewhere teach,) or even by the help of an additament of ſuch clay as is it ſelf a taſtleſs body, will afford a Nitrous ſpirit, that is extreamly ſharp or corroſive upon the tongue, and will diſſolve ſeveral Metals themſelves, and a fixt ſalt, that is likewiſe

wise very strongly tasted, but of a tast altogether different from that of the Spirit, that is extreamly sharp or corrosive upon the tongue; and accordingly, this salt will dissolve divers compact bodies that the other will not work on, and will precipitate divers metals and other concretes out of those solutions, that have been made of them by the Spirit.

EXPER. II.

Of two Bodies, the one highly Acid and corrosive, and the other Alkalizat and fiery, to produce a Body almost insipid.

THis may be performed by the way I have elsewhere mentioned of composing Salt-peter. For if upon a liquour of fixt Nitre, made *per Deliquium*, you warily drop good Spirit of Nitre, till it be just enough to satiate the Alkaly, (for if there

be too much or too little, the Experiment may miscarry,) we may by a gentle evaporation, and sometimes without it, and that in a few minutes, obtain Crystals, which, being dried after they have been, if it be needfull, freed from any adhering particles, (not of their own nature,) will have upon the tongue neither a sharp nor an alkalizate taste, but that faint and scarce sensible bitterness that belongs to Salt-peter, if it be pure Salt-peter; for the impure may perhaps strongly relish of the common Salt that is usually contained in it.

The like production of Salt-peter we have sometimes made in far less time, and sometimes indeed in a trice, by substituting, in stead of the fixed Salt of Nitre, the saline parts of good Pot ashes, carefully freed by solution and filtration from the earthy and feculent ones.

I have sometimes considered, whether the *Phænomena* of these two Experiments may not be explicated by supposing them to arise from the new mag-

magnitudes and figures of the particles, which the fire, by breaking them, or forcibly rubbing them one againſt the other, or alſo againſt the Corpuſcles of the additament, may be preſumed to give them; as if, for example, ſince we find the larger and beſt formed Cryſtals of Nitre to be of a priſmatical ſhape with ſix ſides, we ſhould ſuppoſe the corpuſcles of Nitre to be little priſms, whoſe angles and ends are too obtuſe or blunt to make vigorous and deep impreſſions on the tongue; and yet, if theſe little priſms be by a violent heat ſplit, or otherwiſe broken, or forcibly made as it were to grind one another, they may come to have parts ſo much ſmaller than before, and endowed with ſuch ſharp ſides and angles, that, being diſſolved and agitated by the ſpittle that uſually moiſtens the tongue, their ſmalneſs may give them great acceſs to the pores of that organ, and the ſharpneſs of their ſides and points may fit them to ſtab and cut, and perhaps ſear the nervous and

and membranous parts of the organ of Taſt, and that variouſly, according to the grand diverſities, as to ſhape and bulk, of the ſaporifick particles themſelves. And this being granted, it ſeemed further conceivable, that when the Alkalizate and Acid particles come to be put together in the fluid mixture, wherein they ſwam, many of them might, after a multitude of various juſtlings and occurſions, meet with one another ſo luckily and opportunely, as to recompoſe little priſms, or convene into other bodies, almoſt like thoſe that made up the Cryſtals of Nitre, before 'twas expoſed to the fire. To illuſtrate which, we may conceive, that, though a priſm of iron may be ſo ſhaped, that it will be wholly unfit to pierce the skin; yet it may be ſo cut by tranſverſe planes reaching to the oppoſite *baſes* or ends, as to afford wedges, which, by the ſharpneſs of their edges, may be fit both to cleave wood, and cut the skin; and theſe wedges, being again put together after a requiſite

quiſite manner, may recompoſe a priſm, whoſe extreams ſhall be too blunt to be fit for the former uſe. This may be alſo illuſtrated by the breaking of a dry ſtick circularly cut off at the ends, which though it is unapt, whilſt intire and of that bulk, to prick the hand; yet if it be violently broken, the ragged ends of it and the ſplinters may prove ſtiff, ſlender, and ſharp enough to pierce and run into the hand: To which divers other ſuch Mechanical Illuſtrations might be added. But, ſince I fear you think, as well as I, the main conjecture may not be worthy any farther proſecution, I ſhall not inſiſt any longer on it. And becauſe the hiſtorical part of theſe Experiments was for the main delivered by me already in the Eſſay about the *Analyſis* and Redintegration of Nitre, I ſhall now proceed to other Trials.

EXPER.

EXPER. III.

Of two Bodies, the one extreamly bitter, and the other exceeding ſalt, to make an inſipid mixture.

TO make this Experiment, we muſt very warily pour upon Cryſtals made of Silver, diſſolved in good Aqua fortis or Spirit of Nitre, ſtrong brine made of common ſalt and water. For the mixture of theſe two being dried, and afterwards brought to fuſion in a Crucible, and kept a competent while in that ſtate, will afford a tough maſs, the Chymiſts call *Luna Cornea*, which you may lick divers times, and ſcarce judge it other than inſipid; nor will it eaſily be brought to diſſolve in much more piercing Menſtruums than our ſpittle, as I have elſewhere ſhewn.

EXPER.

EXPER. IV.

Of two Bodies, the one extreamly ſweet, and the other ſalter than the ſtrongeſt Brine, to make an inſipid mixture.

THE doing of this requires ſome skill and much wariness in the Experimenter, who, to perform it well, muſt take a ſtrong ſolution of *Minium*, made with an appropriated Menſtruum, as good Spirit of Vinegar, or elſe *Saccharum Saturni* it ſelf, diſſolved in a convenient Vehicle; and then muſt have great care and caution to put to it, by degrees, a juſt proportion of ſtrong Spirit of Sal Armoniac, or the like Urinous Spirit, till the whole be precipitated; and if the two former taſts are not ſufficiently deſtroyed in the mixture, it may be dried and fluxed, as was above directed about *Luna Cornea*.

EXPER.

EXPER. V.

Of an inſipid Body and a ſour one, to make a Subſtance more bitter than Gall or Aloes.

THis is eaſily performed by diſſolving in ſtrong Spirit of Nitre or good Aqua fortis as much pure Silver as the Menſtruum will take up; for, this ſolution being filtrated, has been often eſteemed more bitter than ſo much Gall or Wormwood, or any other of thoſe ſimples that have been famous for that quality: And if the ſuperfluous moiſture be abſtracted, you may by coagulation obtain Cryſtals of Luna, that have been judged more ſtrongly bitter than the ſolution it ſelf. And that the corpuſcles of theſe Cryſtals ſhould leave a far more laſting taſt of themſelves, than the above-mentioned bitter bodies are wont to doe, will not ſeem ſo marvellous, as I remember ſome that tried have complained; if we take

take notice, how deep the particles of theſe Cryſtals may pierce into the ſpungy organs of Taſt, ſince, if one does but touch the pulp or nail of ones finger, (firſt a little wetted with ſpittle or otherwiſe,) with the powder of theſe Cryſtals, they will ſo penetrate the skin or nail, and ſtick ſo faſt there, that you cannot in a reaſonable time waſh the ſtain off of the skin, and much leſs off of the nail, but it will continue to appear many hours on the former, and many days on the other.

EXPER. VI.

Of an inſipid Body and a highly corroſive one, to make a Subſtance as ſweet as Sugar.

THis is eaſily done, by putting upon good Minium purified Aqua fortis or Spirit of Nitre, and letting them work upon one another in a gentle heat, till the liquour have diſſol-

diſſolved its full proportion of the metal. For then, if the ingredients were good, and the operation rightly performed, the Menſtruum would have a ſweetneſs like that of ordinary *Saccharum Saturni*. But 'twas not for nothing that I intimated, the ingredients ſhould be alſo pure and good in their kind; for, if the *Minium* be adulterated, as often it is, or the Spirit of Nitre or Aqua fortis be mingled, as it is uſual before it be purged with Spirit of common Salt or other unfit ingredients, the operation may be ſucceſsleſs, as I have more than once obſerved.

EXPER. VII.

Of obtaining without addition from the ſweeteſt Bodies, Liquours corroſive enough to diſſolve Metals.

IF Sugar be put into a ſufficiently capacious Retort, and warily diſtilled, (for otherwiſe it will be apt to

to break the Vessel) it will afford, among other things, a copious red Spirit, which, being slowly rectified, will lose its colour, and come over clear. The *Caput Mortuum* of the Sugar, which I have more than once had of an odd Contexture, may be found either almost or altogether insipid. And though the Spirit will be of a very penetrant taste, yet it will be very far from any kind of sweetness; and though that liquour be thought to be homogeneous, and to be one of the Principles of the analized Sugar, yet (as I have elsewhere shewn) I found it to be a mixture of two Spirits; with the one of which, besides bodies of a less close Texture, I dissolved (even in the cold) crude Copper, as was easie to be seen by the deep and lovely colour of the solution. And to these four Spirits, afforded by Sugar it self, we have restored a kind of Saccharine sweetness, by compounding them with the particles of so insipid a body as Minium; part of which

they will in digeſtion diſſolve. A like Spirit to that diſtilled from Sugar may be obtained from *Honey*; but in regard of its aptneſs to ſwell exceedingly, Chymiſts are not wont to diſtill it without Sand, Brick, or ſome other additament.

EXPER. VIII.

To divide a Body, bitter in the higheſt degree, into two Subſtances, the one extreamly ſour, and the other perfectly inſipid.

THis is eaſily done by putting ſome fine Cryſtals of *Luna* into a good Retort, and then diſtilling them in a Sand-furnace, capable of giving them ſo ſtrong a fire, as to drive away all the ſpirits from the Silver. For, this remaining behind, according to its metalline nature, will be inſipid, and the ſpirits, that are driven away from it, will unite in the Receiver into an acid and corroſive Menſtruum. EX-

EXPER. IX.

To produce variety of Tasts in one insipid Body, by associating it with divers Menstruums.

AS this operation may, upon the account I elsewhere mention, be serviceable to investigate the figures of the particles of dissolved metals and other bodies; so 'tis very fit to manifest, what we would here have it shew, how much Tast may be diversified by, and consequently depend upon, Texture; since a body that has no tast, may, in conjunction with sapid bodies, give them strong tasts all differing from one another, and each of them from that which the saporous bodies had before. I could propose divers ways of bringing this to trial, there being several insipid bodies, which I have found this way diversifiable. But because I remember not, that I have met with any mineral, that is

diſſoluble by near ſo many ſaline Menſtruums, as Zinke, I look on that as the moſt fertile Subject to afford Inſtances to our preſent purpoſe. For I have found, that it will be diſſolved not onely by Aqua fortis, Aqua Regis, Oil of Vitriol, Spirit of Nitre, Spirit of Salt, and other mineral Menſtruums, but alſo by Vegetable Spirits, as diſtilled Vinegar, and by Animal ones too, as Spirit of Sal Armoniac; though the one be Acid, and the other Urinous. And if the ſeveral Solutions, which may be made of this mineral, by ſo many differing liquours, be compared, the number of their differing taſts will ſuffice to make good the Title of the Experiment.

EXPER. X.

To produce variety of Tasts with one Menstruum, by associating it with insipid Bodies.

THis Propoſition a Mathematician would go near to call the Converſe of the foregoing; and as it may ſerve as well as that to diſcover the ſtructure of the minute parts of divers metalline and mineral bodies; ſo it may not onely as well, but better than that, ſerve us to illuſtrate the Corpuſcularian Doctrine of Taſts, by ſhewing us, that a ſingle, and, as far as Chymiſtry teaches us, a ſimple body, endowed with a peculiar taſt, may, by being compounded with others, each of them inſipid of it ſelf, produce a conſiderable number of differing taſts. There may be more Inſtruments than one made uſe of in this Trial; but of thoſe that are known, and we may eaſily obtain, the moſt proper are Spirit of Nitre,

and good Aqua fortis: For that, with refined *Silver*, will make a Solution bitter as Gall; with *Lead*, 'twill be of a Saccharine ſweetneſs; with that part of *Tin*, which it will keep diſſolved, (for the greateſt 'tis wont but to corrode and præcipitate) it produces a taſt very diſtant from both the former, but not odious; with *Copper*, it affords an abominable taſt; with *Mercury* and *Iron*, it affords other kinds of bad Taſts. Nor are Metals the onely mineral bodies it will work upon: For, 'twill diſſolve Tin-glaſs, Antimony, Braſs; to which I could add Emery, Zinke, and other bodies whereon I have tried it. All which together will make up no deſpicable number of differing Taſts.

EX-

EXPER. XI.

Of two Liquours, the one highly corrosive, and the other very pungent and not pleasant, to compose a Body of a pleasant and Aromatick Tast.

THis Experiment, which I elsewhere mention to other purposes, does in some regards better suit our present design, than most of the foregoing; since here the Corrosive Menstruum is neither mortified by fixt nor urinous Salts, supposed to be of a contrary nature to it; nor yet, as 'twere, tired out nor disarm'd by corroding of metals or other solid bodies. The Experiment being somewhat dangerous to make at first in great, it may suffice for our present turn, to make it in the less quantity, as follows.

Take one ounce of strong Spirit of Nitre, or of very good Aqua fortis it self, and put to it by little and little, (which caution if you neglect, you

may ſoon repent it,) and another ounce of ſuch rectified Spirit of Wine, as, being kindled in a Spoon, will flame all away: When theſe two liquours are well mixt, and grown cold again, you may, after ſome digeſtion, or, if haſt require, without it, diſtill them totally over together, to unite them exquiſitly into one liquour, in which, if the operation have been well performed, the corroſive particles of the Salts will not onely looſe all their cutting acidity, wherewith they wounded the palat; but by their new compoſition with the Vinous Spirits, the liquour acquires a Vinous taſt, that is not onely not acid or offenſive, but very pleaſing, as if it belonged to ſome new or unknown Spice.

EX-

EXPER. XII.

To imitate by Art, and sometimes even in Minerals, the peculiar Tasts of natural Bodies, and even Vegetables.

THis is not a fit place to declare, in what sense I do or do not admit of Souls in Vegetables, nor what I allow or deny to the Seminal or Plastick principle ascribed to Plants: But perhaps it will not be erroneous to conceive, that, whatever be the Agent in reference to those Tasts, that are said to be specifick to this or that Plant, that, on whose immediate account it is or becomes of this or that nature, is a complication of Mechanical Affections, as shape, size, *&c.* in the particles of that matter which is said to be endowed with such a specifick tast.

To illustrate this, I thought it expedient, to endeavour to imitate the tast of some Natural bodies by Artificial

cial Compoſitions or Preparations, but found it not eaſie, beforehand to be aſſured of the ſucceſs of ſuch Trials: And therefore I ſhall content my ſelf here to mention three or four Inſtances, that, except the firſt, are rather Obſervations than ſuch Experiments as we are ſpeaking of.

I remember then, that, making ſome Trials to alter the ſenſible Qualities of Smell, Taſt, &c. of Oil of Vitriol, and Spirit of Wine, I obtained from them, among other things that ſuited with my deſign, a certain Liquour, which, though at firſt pleaſant, would, at a certain nick of time, make one that had it in his mouth think it had been imbued with Garlick.

And this brings into my mind, that a skilful perſon, famous for making good Sider, coming one day to adviſe with me, what he ſhould doe to heighten the taſt of it, and make it keep the longer, complained to me, that having, among other trials, put into a good Veſſel full of juice of Apples

Apples a certain proportion of Mustard-seed, with hopes it would make the Sider more spirituous and pickant, he found, to his wonder and loss, that, when he came to draw it, it stank of Garlick so rank, that every body rejected it.

I remember also, that, by fermenting a certain proportion (for that we found requisite) of *semen Dauci* with Beer or Ale, the Liquour had a very pleasant Relish of Limon-pills.

But that seems much more considerable, which I shall now add; That, with an insipid Metal and a very corrosive Menstruum, one may compound a tast, that I have several times observed to be so like a Vegetable, that I presume it may deceive many. This may be done by dissolving Gold, without any gross Salt, in the mixture of Aqua fortis and the Spirit of Salt, or even in common Aqua Regis, made by dissolving Sal Armoniac in Aqua fortis. For if the Experiment be happily made, one may obtain either a Solution or a

Salt,

Salt, whose austere tast will very much resemble that of Sloes, or of unripe Bullace. And this tast, with some little variety, I found in Gold dissolved without any distilled Liquour at all; and also, if I much forget not, in Gold that by a peculiar Menstruum I had volatilized.

The last Instance I shall give of the imitation of Tasts, I found to have been, for the main, known to some ingenious Ladies. But to make the Experiment succeed very well, a due proportion is the principal Circumstance, which is wont to be neglected. I cannot readily call to mind that which I found to succeed best; but the Trial may be indifferently well made after such a manner as this:

Take a pint or a pound of *Malaga* or *Canary* Sack, (for though *French* and the like Wines may serve the turn, yet they are not so proper;) and put into it a drachm or two of good odoriferous Orrice Roots, cut into thin slices, and let them infuse in

in the Liquour a convenient time, 'till you perceive that they have given it a desired taſt and ſmell; then keep the thus perfumed Wine exactly ſtopped in a cool place: According to which way, I remember, that (when I hit on the right proportion of Ingredients, and kept them a due time in infuſion) I had many years ago a Wine, which, being coloured with *Cocheneele*, or ſome ſuch tingeing ingredient, was taken for good Raſberry-Wine, not onely by ordinary perſons, but, among others, by a couple of eminent Phyſicians, one of whom pretended to an extraordinary criticalneſs of palate on ſuch occaſions; both of them wondering, how at ſuch an unlikely time of the year, as I choſe to preſent them that Liquour among others, I could have ſuch excellent Rasberry-Wine: Some of which (to add that by the by) I found to preſerve the ſpecifick taſt two or three years after it was made.

A Short

EXCURSION

About ſome Changes made

OF

TASTS

BY

MATURATION.

IT will not perhaps be thought impertinent, but rather neceſſary, to add a word or two on this occaſion for their ſakes, that think the Maturation of Fruits, and the changes of Taſts, by which 'tis uſually known, muſt needs be the effect of the Vegetable Soul of the Plant. For, after the Fruit is gathered, and ſo, by being no longer a part of the Tree, does,

does, according to the moſt common opinion, ceaſe to be a part of the living Plant, as a Hand or a Foot cut off is no more reckoned among the Lims of the man it belonged to; yet 'tis very poſſible that ſome Fruits may receive maturation, after they have been ſevered from the Plants that bore them. For, not to mention, that Apples, gathered ſomewhat before the time, by lying in heaps, do uſually obtain a mellowneſs, which ſeems to be a kind or degree of Maturation; or that Medlars, gathered whilſt they are hard and harſh, do become afterwards in proceſs of time ſoft and better taſted; in which ſtate though ſome ſay they are rotten, yet others think that ſuppoſed rottenneſs is the proper Maturity of that kind of Fruit: Not to mention theſe, I ſay, or the like Inſtances, 'tis a famous Aſſertion of ſeveral Writers of the Indian affairs, that the Fruit they call *Bananas* is uſually gathered green, and hung up in bunches or cluſters in the houſe, where they ripen by degrees,

grees, and have an advantageous change made both of their colour and of their taſt. And this an ancient acquaintance of mine, a literate and obſerving perſon, of whom I inquired about it, aſſured me, he had himſelf lately tried and found to be true in *America*. And indeed I ſee not, why a convenient degree of warmth, whether external from the Sun and Fire, or internal from ſome degree of fermentation or analogous inteſtine Commotion, may not (whether the Fruit be united to the Plant or no) put the ſaporifick Corpuſcles into motion, and make them, by various and inſenſible tranſcurſions, rub againſt each other, and thereby make the little bodies more ſlender or thin, and leſs rigid, or cutting and harſh, than they were before, and by various motions bring the Fruit they compoſe to a ſtate wherein it is more ſoft in point of conſiſtence, and abound in Corpuſcles leſs harſh and more pliable, than they were before, and more congruous to

to the pores of the organ of Taſt: And, in a word, make ſuch a change in the conſtitution of the Fruit, as men are wont to expreſs by the name of *Maturity*. And that ſuch Mechanical changes of Texture may much alter the Qualities, and among them the Taſt of a Fruit, is obvious in bruiſed Cherries and Apples, which in the bruiſed parts ſoon come to look and taſt otherwiſe than they did before. The poſſibility of this is alſo obvious by *Wardens*, when ſlowly roaſted in embers with ſo gentle a fire, as not to burn off the paper they are wont to be wrapt in, to be kept clean from the aſhes. And I have ſeen, in the bordering Country betwixt *France* and *Savoy*, a ſort of Pears, (whoſe name I now remember not,) which being kept for ſome hours in a moderate heat, in a Veſſel exactly cloſed, with embers and aſhes above and beneath them, will be reduced to a juicy Subſtance of a lovely red colour, and very ſweet and luſhious to the taſt. Many other ſorts

of Fruit in other Countries, if they were handled after the same way, or otherwise skilfully wrought on by a moderate heat, would admit as great alterations in point of taſt. Neither is that ſort of Pear to be here omitted, which by meer Compreſſion, duly ordered, without external heat, will in a few minutes be brought to exchange its former hardneſs and harſhneſs for ſo yielding a Contexture and pleaſant a taſt, as I could not but think very remarkable. And that even more ſolid and ſtubborn Salts than thoſe of Vegetables, may have the ſharpneſs and piercingneſs of their taſts very much taken off by the bare internal action of one part upon the other, without the addition of any ſweetning body, I have been induced to think by having found, upon trial, that, by the help of inſipid Water, we may, without any violence of Fire, reduce Sea-ſalt into a Brine of ſo mild and peculiar (I had almoſt ſaid) pleaſant a taſt, that one would ſcarce ſuſpect what it had been,

been, or believe that ſo great a change of a Mineral body could be effected by ſo ſlight an inteſtine Commotion as indeed produced it; eſpecially, ſince the alteration of taſts was not the moſt conſiderable that was produced by this Operation.

As to Liquours that come from Vegetables, the emerging of new *Sapors* upon the inteſtine Commotion of the ſaporifick parts, as Conſequences of ſuch Commotions, is more obvious than is commonly conſidered in the juice of Grapes, which, from a ſweet and ſpiritleſs Liquour, do by that internal motion we call Fermentation, acquire that pleaſing pungency and briskneſs of taſt that belongs to Wine, and afterwards degenerates into that acid and cutting taſt that is proper to Vinegar; and all this, by a change of Conſtitution made by the action of the parts themſelves on one another, without the help of any external additament.

FINIS.

EXPERIMENTS,

AND

OBSERVATIONS,

About the

Mechanical Production

OF

ODOURS.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

LONDON,
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EXPERIMENTS,

AND

OBSERVATIONS,

About the

Mechanical Production

OF

ODOURS.

SInce *Tasts* and *Odours* (perhaps by reason of the nearness of the Organs they affect) are wont, by Physical Writers, to be treated of next to one another, I also shall imitate them in handling those two Qualities, not onely for the intimated Reason, but because, what I have premised in general, and some other things that I have said already under the Title of *Tasts*, being applicable

to Odours also, 'twill not be necessary, and therefore 'twould be tedious, to repeat them here.

EXPER. I.

With two Bodies, neither of them odorous, to produce immediately a strong Urinous smell.

TAke good Quick-lime and Sal Armoniac, and rub or grind them well together, and holding your Nose to the mixture, you will be saluted with an Urinous smell produced by the particles of the volatil Salt, untied by this operation, which will also invade your Eyes, and make them to water.

EX-

EXPER. II.

By the bare addition of common Water, to produce immediately a very ſtrong ſmell in a Body that had no ſuch ſmell before.

THis is one of the Phænomena of an Experiment made with Camphire and Oil of Vitriol, which I have elſewhere mentioned to another purpoſe. For, if in that corroſive *Menſtruum* you diſſolve a good proportion, but not too much, of the ſtrongly ſented Gum, the odour of the Camphire will be quite concealed in the mixture; but if you pour this mixture into a good quantity of fair Water, the diſſolved Gum will immediately recover out of the *Menſtruum*, and ſmell as ſtrong as before, if not (by reaſon of the warmth produced in the Operation) more ſtrongly.

EXPER. III.

Of producing ſome Odours, each of them quite differing from that of any of the Ingredients.

HAving taken two ounces (or parts) of clear Oil of Turpentine, and mixt it with one ounce (or part) of Oil of Vitriol, (which muſt be done by degrees, for otherwiſe the Veſſel will be endangered,) the clear Liquour that came over, upon the diſtillation of the mixture in a Sand-furnace, in ſtead of the odour of Turpentine, (for the Oil of Vitriol alone is wont to be inodorous,) ſmelt very ſtrong of Sulphur; inſomuch that once, when I ſhewed this Experiment, approaching my Noſe very boldly and haſtily to the Receiver newly ſevered from the Retort, the ſulphureous ſtink proved ſo ſtrong, that it had almoſt (to ſpeak with the vulgar) taken away my breath. And to illuſtrate yet farther the poſſible emer-

emergency of ſuch odours upon the mixture of Ingredients, as neither of them was apart endowed with, we cauſed the ſubſtance that remained behind in the Retort (in the form of a thin extract) after one of the newly mentioned Diſtillations to be farther preſſed by a ſtronger fire, which forced moſt of it over, partly in the form of a thick Oil, and partly in that of Butter; both which we keep together in the ſame Vial, becauſe their odour is neither that of Oil of Turpentine, nor that of Brimſtone, but they ſmell exceedingly like the diſtilled Oil of Bees-wax.

EXPER. IV.

About the production of ſome Odours by Local motion.

I Shall not now examine, whether the Local motion of an external Agent may not, without materially concurring to the operation, pro-

duce, by agitating and ſhuffling the parts, odorous corpuſcles: But that the celerity and other modifications of the Local motion of the *effluvia* of Bodies may not onely ſerve to diverſifie their odours, but ſo far produce them, as to make them perceptible by the ſenſe, which otherwiſe would not be ſo, may be gathered from ſome obſervations, which, being obvious, are not ſo proper for this place. Wherefore I ſhall rather take notice, that I know ſeveral Bodies that are not onely inodorous when cold, but when conſiderably hot, and are fixt in the fire, and yet, by having their parts put into a peculiar kind of agitation, will preſently grow plainly odorous. On this occaſion I ſhall add, that, as there are ſome very hard Woods, that acquire a ſtrong ſmell by the motion they may be expoſed to in a Turner's Lath, (as I have obſerved by trialls particularly made with the hard and ponderous *Lignum Vitæ*,) ſo ſome afford, whilſt the operation laſts, an unexpected odour.

And

And having inquired about this matter of two eminent Artists, (whom I often employ,) concerning the odour of Beech-wood whilst it is turning, they both agreed, that it would emit well-scented *effluviums*. And one of them affirmed to me farther, that, having bought a great block of that Wood, to make divers pieces of workmanship with it, when he came to turn it, there would issue out not onely a copious odour, but of such a peculiar fragrancy, that one that knew not whence it proceeded would have concluded he was smelling Roses.

EXPER. V.

By mixing a good proportion of a very strongly scented Body with an almost inodorous one, to deprive it speedily of all its smell.

TAke Salt of Tartar, and drop upon it either Spirit of Nitre or Aqua fortis not too much dephlegmed,

phlegmed, till all the effervescence cease, and the Liquour will no longer work upon the Alkali. These, by a slow Evaporation of the superfluous moisture, may be made to shoot into Crystalls like those of Nitre, which, after you have (if need be) by rubbing them with a dried cloath, freed them from loose adhering Corpuscles, will emulate Salt-peter, as in other Qualities, so in its not being odorous; though, if you distill them, or burn them on kindled coals, their fumes will quickly make you sensible, that they abounded with the stinking Spirits, that make *Aqua fortis* so offensive to the smell.

EX-

EXPER. VI.

By putting a very ſtrongly ſtinking Body to another of a not ſweet ſmell, to produce a mixture of a pleaſant and ſtrongly Aromatick odour.

WHat is here propoſed is performed at the ſame time that the Eleventh of the foregoing Experiments of Taſts is made. For the Liquour thereby produced, if it be well prepared, has not onely a ſpicy *taſt*, but alſo a kind of Aromatick and pleaſant *ſmell*; and I have ſome now by me, that, though kept not over-carefully, does, after ſome years, retain much of its former odour, though not ſo much as of its taſt.

EX-

EXPER. VII.

By digesting two Bodies, neither of them well sented, to produce Bodies of a very subtile and strongly fragrant odour.

WE took a pound (for instance) of Spanish Wine, and put to it some ounces of Oil of Vitriol; then, keeping them for a reasonable time in digestion, we obtained, as we expected, a mixture odoriferous enough. But this Triall you will find improved by that which insues.

EX-

EXPER. VIII.

By the bare addition of a Body almoſt inodorous, and not well ſented, to give a pleaſant and Aromatick ſmell to Spirit of Wine.

THis we have ſeveral times done, by the ways elſewhere related for another ſcope, the ſumm of which, as far as it needs be mentioned in this place, is this.

We took good Oil of blew Vitriol (that was brought from *Dantzick*,) though the very common will ſerve well, and having put to it, by degrees, an equal weight of Spirit of Wine totally inflammable, we digeſted them together, for two, three, or four weeks, (ſometimes much longer, and then with better ſucceſs;) from which, when we came to diſtill the mixture, we had a very fragrant Spirit, which was ſometimes ſo ſubtile, that, though diſtilled in a tall Glaſs with a gentle Heat, it would (in

(in ſpite of our care to ſecure the cloſeneſs of the Veſſels at the junctures) pierce through, and fill the Laboratory with a perfume, which, though men could not gueſs what body afforded it, yet they could not but wonder at it. Whence we may learn, both *how much* thoſe ſpirituous and inflammable particles, the Chymiſts call the vegetable Sulphur of Wine, may work on and ennoble a mineral Sulphur; (for, that ſuch an one there is in Oil of Vitriol, I have elſewhere proved by experience;) and *how much* the new Commiſtions and Contextures made by digeſtion may alter the odours of Bodies, whether Vegetable or Mineral. That alſo another Conſtitution of the ſame matter, without any manifeſt addition or receſs of particles, may proceed to exhibit a very differing ſmell, will appear by the following Triall.

EX-

EXPER. IX.

To make the forementioned fragrant Body, without addition or fire, degenerate into the rank ſmell of Garlick.

TO make out this, I need onely relate, that I have more than once put the above mentioned fragrant Liquour in ſtopt Glaſſes, whereof the one, and not the other, ſtood in a warm place, till in proceſs of time I found that odoriferous Liquour ſo to degenerate in point of ſent, that one would have thought it to have been ſtrongly infected with Garlick. And the like unpleaſant Smell I obſerved in a certain Oil made of Vegetable and Mineral Subſtances diſtilled together.

And on this occaſion I will add, (though not as an Argument,) this Obſervation, which though I ſhall not undertake it will always ſucceed, I think may not impertinently be ſet down

down in this place, partly becauſe of the likeneſs of the odour produced, to that which was the effect of the laſt named Triall; and partly (or rather chiefly) becauſe it may ſhew us, that a Body, which it ſelf is not onely inodorous, but very fixt, may yet, in ſome caſes, have a great ſtroke in the *Phænomena* of Odours; whether by being wrought on by, and ſometimes mingled with, the parts of the odorous body, and thereby giving it a new modification, I ſhall not now ſtay to enquire.

We took then good Salt of Tartar, and put to it ſeveral times its weight of the expreſſed juice of Onions; we kept them in a light digeſtion for a day or two, and then unſtopping the Vial, we found the former ſmell of the Onions quite degenerated into a rank ſmell of Garlick, as was judged, even when freſh juice of Garlick was procured to compare them. To vary this Experiment, we made with fixt Salts, and ſome other ſtrongly ſented Juices, Trialls, whoſe events

'twould

'twould perhaps be tedious here to relate.

EXPER. X.

With an inodorous Body, and another not well-ſented, to produce a muskie ſmell.

THis we have ſometimes done by caſting into Spirit (not Oil) of Vitriol a large proportion of ſmall Pearls unbroken. For the action of the acid Menſtruum upon theſe being moderated, partly by the weakneſs of the Menſtruum, and partly by the intireneſs of the Pearls, the diſſolution would ſometimes laſt many hours. Holding from time to time my noſe to the open orifice of the Glaſs, 'twas eaſie to perceive a pleaſant muskie ſmell, which alſo others, to whom I mentioned it, took notice of as well as I. And, if I miſremember not, I took notice of the like ſmell, upon Pearls not onely

diſſolved in Spirit of Vinegar, but in another Liquour that had but a bad ſent of its own. The foregoing Experiment calls to my mind that which follows.

EXPER. XI.

With fixt Metals, and Bodies either inodorous or ſtinking, to produce ſtrong and pleaſant ſmells, like thoſe of ſome Vegetables and Minerals.

THat Gold is too fixt a body to emit any odour, and that Aqua Regis has an odour that is very ſtrong and offenſive, I think will be eaſily granted. But yet *Aurum fulminans* being made (as 'tis known) by precipitating with the inodorous Oil of Tartar the Solution made of the former in the latter, and this Precipitate being to be farther proceeded with in order to another Experiment; we fulminated it *per ſe* in a Silver Veſſel like that, but better

ter contrived, that is (if I misremember not) somewhere described by *Glauberus*. And among other *Phænomena* of this operation, that belong not to this place, we observed with pleasure, that, when the fulmination was recently made, the steams, which were afforded by the metal that had been fired, were endowed with a delightful smell, not unlike that of musk. From which Experiment and the foregoing we may learn, that Art, by lucky Contextures, may imitate the odours that are presumed to be natural and specifick; and that Mineral and Vegetable Substances may compound a smell that is thought to be peculiar to Animals.

And as Art sometimes imitates Nature in the production of Odours, as may be confirmed by what is above related concerning counterfeit Rasberry-Wine, wherein those that drank it believed they did not onely taste, but smell the Rasberry; so sometimes Nature seems

See in the Paper of Tasts, Exper. XII.

to imitate her ſelf, in giving like odours to bodies extreamly differing. For, not yet to diſmiſs the ſmell of Musk, there is a certain Seed, which, for the affinity of its odour to that perfume, they call the *Musk-ſeed*; and indeed, having ſome of it preſented me by a Gentleman, that had newly brought it from the *Weſt-Indies*, I found it, whilſt 'twas freſh, to have a fragrancy ſuitable to the name that was given it. There is alſo a ſort of Rats in *Muſcovy*, whoſe skins, whereof I have ſeen ſeveral, have a ſmell that has procured them the name of *Musk-Rats*. To which I know not, whether we may not add the mention of a certain ſort of Ducks, which ſome call *Musk-Ducks*, becauſe at a certain ſeaſon of the year, if they be chaſ'd by violent motion, they will under the wing emit a musky in ſtead of a ſweaty ſent; which upon trial I perceived to be true. On the other ſide, I have known a certain Wood growing in the *Indies*, which, eſpecially when the ſent is excited by

rub-

rubbing, ſtinks ſo rankly and ſo like *Paracelſus's Zibetum Occidentale*, (*ſtercus Humanum*,) that one would ſwear it were held under his Noſe. And ſince I have been ſpeaking of good ſents produced by unlikely means, I ſhall not pretermit this Obſervation, that, though generally the fire impreſſes a ſtrong offenſive ſmell, which Chymiſts therefore call *Empyreumatical*, upon the odorous bodies that it works ſtrongly on; yet the conſtitution of a body may be ſuch, that the new Contexture that is made of its parts, even by the violence of the fire, ſhall be fit to afford Effluviums rather agreeable to the organs of ſmelling, than any way offenſive. For I remember, that, having for a certain purpoſe diſtilled *Saccharum Saturni* in a Retort with a ſtrong fire, I *then* obtained, (for I dare not undertake for the like ſucceſs to every Experimenter,) beſides a piercing and Empyreumatical Liquour that was driven over into the Receiver, a good Lump of a *Caput*

Mortuum of a grayiſh colour, which, notwithſtanding the ſtrong impreſſion it had received from the fire, was ſo far from having any Empyreumatical ſent, that it had a pleaſing one, and when 'twas broken, ſmelt almoſt like a fine Cake new baked, and broken whilſt yet warm. And as the fire, notwithſtanding the *Empyreuma* it is wont to give to almoſt all the bodies it burns, may yet be reduced to confer a good ſmell on ſome of them, if they be fitted upon ſuch a contexture of their parts to emit ſteams of ſuch a nature, (whatever were the efficient cauſe of ſuch a contexture;) *ſo* we obſerve in the *Muſk animal*, that Nature in that Cat, or rather Deer, (though it properly belong to neither kind,) produces Musk by ſuch a change, as is wont in other Animals to produce a putrefactive ſtink. So that, provided a due conſtitution of parts be introduced into a portion of matter, it may on that account be endowed with noble and deſirable Sents, or other Qualities, though

though that Conſtitution were introduced by ſuch unlikely means, as Combuſtion and Putrefaction themſelves. In Confirmation of which, I ſhall ſubjoyn in the inſuing account a notable, though caſual, Phænomenon, that occurr'd to a couple of *Virtuoſi* of my Acquaintance.

An eminent Profeſſor of Mathematicks affirmed to me, that, chancing one day in the heat of Summer with another Mathematician (who I remember was preſent when this was told) to paſs by a large Dunghil that was then in *Lincolns-Inn-fields*, when they came to a certain diſtance from it, they were both of them ſurprized to meet with a very ſtrong ſmell of Musk, (occaſioned, probably, by a certain degree or a peculiar kind of Putrefaction,) which each was for a while ſhy of taking notice of, for fear his Companion ſhould have laughed at him for it; but, when they came much nearer the Dunghill, that pleaſing ſmell was ſucceeded by a ſtink proper to ſuch a heap of Ex-

crements. This puts me in mind of adding, that, though the excrements of Animals, and particularly their ſweat, are uſually fœtid; yet, that 'tis not the nature of an excrement, but the conſtitutions, that uſually belong to them, make them ſo, hath ſeemed probable to me upon ſome Obſervations. For, not to mention, what is related of *Alexander* the Great, I knew a Gentleman of a very happy Temperature of body, whoſe ſweat, upon a critical examination, wherein I made uſe alſo of a ſurprize, I found to be fragrant; which was confirmed alſo by ſome Learned men of my acquaintance, and particularly a Phyſician that lay with him.

Though *Civet* uſually paſſes for a Perfume, and as ſuch is wont to be bought at a great rate; yet it ſeems to be but a clammy excrement of the Animal that affords it, which is ſecreted into Bags provided by Nature to receive it. And I the rather mention *Civet*, becauſe it uſually affords a Phæ-

a Phænomenon that agrees very well with the Mechanical Doctrine concerning *Odours*, though it do not demonstrate it. For, when I have had the curiosity to visit divers of those Civet-Cats, (as they call them) though they have heads liker Foxes than Cats; I observed, that a certain degree of Laxity (if I may so style it) of the odorous Atmosphere was requisite to make the smell fragrant. For, when I was near the Cages, where many of them were kept together, or any great Vessel full of Civet, the smell (probably by the plenty, and perhaps the over-brisk motion of the *effluvia*,) was rather rank and offensive than agreeable; whereas, when I removed into the next room, or to some other convenient distance, the steams (being less crowded, and farther from their fountain,) presented themselves to my Nostrills under the notion of a Perfume.

And, not to dismiss this our Eleventh Experiment without touching once more

more upon Musk, I ſhall add, that an Ingenious Lady, to whom I am nearly related, ſhewed me an odd *Monkey*, that had been preſented her as a rarity by the then Admiral of *England*, and told me, among other things, that ſhe had obſerved in it, that, being ſick, he would ſeek for Spiders as his proper remedies, for ſome of which he then ſeemed to be looking, and thereby gave her occaſion to tell me this; which when he had eaten, the alteration it made in him would ſometimes fill the room with a musky ſent: But he had not the good luck to light on any whilſt my viſit laſted.

EXPER. XII.

To heighten good ſmells by Compoſition.

'TIS well known to Perfumers, and is eaſie to be obſerved, that Amber-greece alone, though eſteemed the beſt and richeſt perfume that

that is yet known in the world, has but a very faint and ſcarce a pleaſant ſent. And I remember, that I have ſeen ſome hundreds of ounces together newly brought from the *Eaſt-Indies*; but if I had not been before acquainted with the ſmell of Amber-greece alone, and had had onely the vulgar conceit of it, that 'tis the beſt and ſtrongeſt of perfumes, my Noſtrills would ſcarce have made me ſuſpect thoſe lumps to have been any thing a-kin to Amber-greece. But if a due proportion of Musk, or even Civet, be dexterouſly mixt with Amber, the latent fragrancy, though it be thereby ſomewhat compounded, will quickly be called forth, and exceedingly heightned. And indeed 'tis not, as 'tis commonly preſumed, the plenty of the richeſt Ingredients, as Amber-greece and Musk, but the juſt proportion and skilful mixture of them, that makes the nobleſt and moſt laſting perfume, of which I have had ſufficient experience; ſo that with a far leſs quantity of Musk and

and Amber, than not onely ordinary perſons, but Perfumers themſelves are wont to imploy, we have had ſeveral Perfumes, that for fragrancy were much preferred to thoſe where Musk and Amber-greece are ſo plentifully imployed. The proportions and ways of mixture we beſt approved of, would be too long, and are not neceſſary, to be here ſet down; but you will not much erre in making uſe of ſuch a proportion as this, *viz.* eight parts of Amber-greece, two of Musk, and one of Civet: which quantities of Ingredients if they be skilfully and exactly mingled, you will not miſs of a good Compoſition, with which you may innoble other materials, as *Benzoin*, *Storax*, ſweet Flowers, &c. fit to make Paſtills, Ointments for Leather, Pomander, &c. And we may here add, that, upon the ſcore of the new Texture acquired by Compoſition, ſome things, that are not fragrant themſelves, may yet much heighten the fragrancy of Odoriferous bodies.

And

And of liquid perfumes I remember, 'twas the ſecret of ſome Court-Ladies, noted for Curioſity about perfumes, to mingle always a due proportion of Wine-vinegar with the odoriferous Ingredients. And on this occaſion, to ſhew the power of mixtures in improving *Odours*, I ſhall add ſomething about a Liquour of mine, that has had the good fortune to be very favourably ſpoken of by perſons of Quality accuſtomed to choice Perfumes. This Liquour, though thought an elaborate preparation, as well for another reaſon, as to recommend it to ſome, whoſe Critical palates can taſt the very titles of things, I called it *Eſſence of Muſk*, is indeed a very plain ſimple preparation, which I thus make.

I take an arbitrary Quantity of choice Musk without finely powdering it, and pour upon it about a finger's breadth of pure Spirit of Wine; theſe in a Glaſs cloſely ſtopt I ſet in a quiet place to digeſt, without the help of any Furnace, and

after

after ſome days, or a few weeks, (according as Circumſtances determined,) the Spirit, which is ſomewhat odd, will in the cold have made a ſolution of the fineſt parts of the Musk, and will be thereby much tinged, but not of a red colour. This Liquour being decanted, I keep by it ſelf as the richeſt of all; and pour a like quantity of Spirit on the remaining Musk, which uſually will in the cold, though more ſlowly, draw a tincture, but fainter than the former, which being poured off, the remaining Musk may be imployed for inferiour uſes. Now that which made me mention this Preparation as pertinent to our preſent Subject, is this Phænomenon of it, that the firſt eſſence, or rather tincture, being ſmelt to by it ſelf, has but a faint, and not very pleaſing, odour of Musk, ſo that every body would not diſcover that there was Musk in it; but if a ſingle drop, or two drops at moſt, were mixt with a pint, or perhaps a quart, of good Sack, the

the whole body of the Wine would presently acquire a considerably musky scent, and be so richly perfumed both as to taste and smell, as seemed strange enough to those that knew the vast disproportion of the Ingredients.

FINIS.

OF THE

IMPERFECTION

OF THE

Chymiſt's

DOCTRINE

OF

QUALITIES.

By the Honourable
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OF THE IMPERFCTION OF The Chymiſt's Doctrine OF QUALITIES.

CHAP. I.

SInce a great part of thoſe Learned Men, eſpecially Phyſicians, who have diſcerned the defects of the vulgar Philoſophy, but are not yet come to underſtand and reliſh the *Corpuſcularian*, have ſlid into the Doctrine of the Chymiſts; and ſince the Spagyriſts are wont to pretend to make out all the Qualities of bodies from the Predominancy of ſome one of their three *Hypoſtatical*

Principles, I suppose it may both keep my opinion from appearing too presumptuous, and (which is far more considerable) may make way for the fairer Reception of the *Mechanical* Hypothesis about Qualities, if I here intimate (though but briefly and in general) some of those defects, that I have observed in Chymists Explications of Qualities.

And I might begin with taking notice of the *Obscurity* of those Principles, which is no small defect in Notions whose proper office it should be to conduce to the illustration of others. For, how can that facilitate the understanding of an obscure Quality or Phænomenon which is it self scarcely intelligible, or at least needs almost as much explanation as the thing 'tis designed & pretended to explicate? Now a man need not be very conversant in the writings of Chymists to observe, in how Laxe, Indefinite, and almost Arbitrary Senses they employ the Terms of *Salt*, *Sulphur* and *Mercury*; of which I could

could never find that they were agreed upon any certain Definitions or ſetled Notions; not onely differing Authors, but not unfrequently one and the ſame, and perhaps in the ſame Brook, employing them in very differing ſenſes. But I will not give the Chymiſts any riſe to pretend, that the chief fault that I find with their Hypotheſis is but verbal; though that it ſelf may not a little blemiſh any Hypotheſis, one of the firſt of whoſe Requiſites ought to be *Clearneſs*; and therefore I ſhall now advance and take notice of defects that are manifeſtly of another kind.

And firſt the Doctrine that all their Theory is grounded on, ſeems to me *Inevident* and undemonſtrated, not to ſay precarious. It is ſomewhat ſtrange to me, that neither the Spagyriſts themſelves, nor yet their Adverſaries, ſhould have taken notice, that Chymiſts have rather ſuppoſed than evinced, that the Analyſis of bodies by fire, or even that at leaſt ſome *Analyſis* is the onely inſtrument of in-

vestigating what Ingredients mixt bodies are made up of, since in divers cases That may be discovered by Composition as well as by Resolution; as it may appear, that Vitriol consists of metalline parts (whether Martial, or Venereal, or both) associated by Coagulation with acid ones, one may, I say, discover this as well by making true Vitriol with Spirit (improperly called Oil) of Sulphur, or that of Salt, as by distilling or Resolving Vitriol by the fire.

But I will not here enlarge on this subject, nor yet will I trouble you with what I have largely discoursed in the *Sceptical Chymist*, to call in question the grounds on which Chymists assert, that all mixt bodies are compounded of *Salt*, *Sulphur*, and *Mercury*. For it may suffice me now to tell you, that, whatsoever they may be able to obtain from other bodies, it does not appear by Experience, which is the grand, if not the onely, Argument they rely on, that all mixt bodies that have Qualities, consist of their

their *tria prima*, since they have not been able, that we know, truly, and without new Compositions, to resolve into those three, either *Gold*, or *Silver*, or *Crystal*, or *Venetian Talck*, or some other bodies, that I elsewhere name; & yet these bodies are endowed with divers *Qualities*, as the two former with Fusibleness and Malleability, and all of them with Weight and Fixity; so that in these and the like bodies, whence Chymists have not made it yet appear, that their Salt, Sulphur and Mercury, can be truly and adequately separated, 'twill scarce be other than precarious, to derive the malleableness, colour, and other *Qualities* of such bodies from those Principles.

Under this Head I consider also, that a great part of the Chymical Doctrine of Qualities is bottom'd on, or supposes, besides their newly questioned Analysis by fire, some other things, which, as far as I know, have not yet been well proved, and I question whether they ever will be.

One of their main Suppositions is, that this or that Quality must have its πρῶτον δεκτικὸν, as *Sennertus*, the Learnedst Champion of this opinion, calls it, or some particular material Principle, to the participation of which, as of the primary native and genuine subject, all other bodies must owe it: But upon this point having purposely discoursed elsewhere, I shall now onely observe, that, not to mention Local motion and Figure, I think 'twill be hard to shew, what is the πρῶτον δεκτικὸν of Gravity, Volatility, Heat, Sonorousness, Transparency and Opacity, which are Qualities to be indifferently met with in bodies whether simple or mixt.

And whereas the Spagyrists are wont to argue, that, because this or that Quality is not to be derived truly from this or that particular Principle, as *Salt*, for instance, and *Mercury*; therefore it must needs be derivable from the third, as *Sulphur*. This way of arguing involves a farther Supposition than that newly examined.

For

For it implies, that every Quality in a compounded body muſt ariſe from ſome one of the *tria prima*, whereas experience aſſures us, that bodies may, by Compoſition, obtain Qualities, that were not to be found in any of the ſeparate Ingredients. As we ſee in painting, that though blew and yellow be neither of them green, yet their mixture will be ſo. And though no ſingle Sound will make an octave or *diapaſon*; yet two ſounds, whoſe proportion is double, will have an eighth. And Tinn and Copper melted and mingled together in a due proportion, will make a bell-metal far more ſonorous than either of them was before. 'Tis obvious enough for Chymiſts themſelves to obſerve, that, though Lead be an inſipid body, and Spirit of Vinegar a very ſharp one, yet *Saccharum Saturni*, that is compounded out of theſe two, has a ſweetneſs that makes it not ill deſerve its name.

But this ill-grounded Suppoſition of the Chymiſts, is extended farther in

in an usual Topic of theirs, according to which they conclude, That I know not how many Qualities, as well manifest as occult, must be explicated by their *tria prima*, because they are not explicable by the four elements of the *Peripateticks*. To make which argumentation valid, it must be proved, (which I fear it will never be) that there are no other wayes, by which those Qualities may be explicated, but by a determinate number of Material Principles, whether four or three: Besides that, till they have shewn that such Qualities may be intelligibly explicated by *their* Principles, the objection will lye as strong for the *Aristotelians* against them, as for them against the *Aristotelians*.

CHAP. II.

NExt I consider, that there are divers Qualities even in mixt bodies, wherein it does not appear, that the use of the Chymical Doctrine

is

is *Neceſſary*. As, *for inſtance*, when pure *Gold* is by Heat onely brought to fuſion, and conſequently to the ſtate of fluidity, and upon the remiſſion of that heat, grows a ſolid and conſiſtent body again, what addition or expulſion or change of any of the *tria prima* does appear to be the cauſe of this change of conſiſtence? Which is eaſie to be accounted for according to the *Mechanical* way, by the vehement agitation that the fire makes of the minute parts of the Gold to bring it to fuſion; and the coheſion of thoſe parts, by vertue of their gravity and fitneſs to adhere to one another, when that agitation ceaſes. When *Venice Glaſs* is meerly by being beaten to pouder deprived of its Tranſparency and turned into a body opacous and white, what need or uſe of the *tria prima* have we in the explication of this Phænomenon? Or of that other which occurs, when by barely melting down this white and opacous body it is deprived of its opacity and colour, and becomes diapha-

diaphanous? And of this sort of Instances you will meet with divers in the following Notes about particular Qualities; for which reason I shall forbear the mention of them here.

CHAP. III.

I Observe too, that the Spagyrical Doctrine of Qualities is *Insufficient* and too narrow to reach to all the Phænomena or even to all the notable ones, that ought to be explicable by them. And this Insufficiency I find to be two-fold; for, *first*, there are divers Qualities, of which Chymists will not so much as attempt to give us explications, and of other particular Qualities the explications, such as they are that they give us, are often very deficient and unsatisfactory; and do not sometimes so much as take notice of divers considerable Phænomena that belong to the Qualities whereof they pretend to give an account; of which you will

will meet with divers Inſtances in the inſuing Notes. And therefore I ſhall onely, (to declare my meaning the better,) invite you to obſerve with me, that though *Gold* be the body they affect to be moſt converſant with; yet it will be very hard to ſhew, how the ſpecific weight of Gold can be deduced from any or all of the three Principles, ſince *Mercury* it ſelf, that is of bodies, known to us, the heavieſt next to Gold, is ſo much lighter than Gold, that, whereas I have uſually found Mercury to be to an equal weight of water, ſomewhat, though little, leſs than fourteen to one, I find *pure* Gold to be about nineteen times as heavy as ſo much water. Which will make it very difficult, not to ſay impoſſible for them to explain, how Gold ſhould barely by participating of Mercury, which is a body much lighter than it ſelf, obtain that great ſpecific gravity we find it to have; for the two other Hypoſtatical Principles, we know, are far lighter than Mercury. And I think

think it would much puzzle the Chymists, to give us any examples of a compounded body, that is specifically heavier than the heaviest of the Ingredients that it is made up of. And this is the *first* kind of Insufficiency I was taking notice of in the Chymical Doctrine of Qualities.

The *other* is, That there are several bodies which the most Learned among themselves confess not to consist of their *tria prima*, and yet are indowed with Qualities, which consequently are not in those subjects to be explicated by the *tria prima* which are granted not to be found in them. Thus *elementary Water*, though never so pure, (as distilled Rain-water,) has fluidity and coldness and humidity and transparency and volatility, without having any of the *tria prima*. And the purest *Earth*, as Ashes carefully freed from the fixt salt, has gravity and consistence and dryness and colour and fixity, without owing them either to Salt, Sulphur, or Mercury; not to mention, that there are Cele-

Celeſtial bodies which do not appear, nor are wont to be pretended, to conſiſt of the *tria prima*, that yet are indowed with Qualities. As the *Sun* has Light, and as many Philoſophers think, Heat, and Colour; and the *Moon* has a determinate conſiſtence and figuration, (as appears by her mountains) and Aſtronomers obſerve, that the higher Planets and even the Fixt ſtars appear to be differingly coloured. But I ſhall not multiply Inſtances of this kind, becauſe what I have ſaid, may not onely ſerve for my preſent purpoſe, but bring a great Confirmation to what I lately ſaid, when I noted, that the Chymical Principles were in many caſes *not neceſſary* to explicate Qualities: For ſince in Earth, Water, &c. ſuch diffuſed Qualities, as gravity, fixtneſs, colour, tranſparency and fluidity, muſt be acknowledged not to be derived from the *tria prima*; 'tis plain, that portions of matter may be endowed with ſuch Qualities by other cauſes and agents than Salt, Sulphur

Sulphur and Mercury. And then why ſhould we deny, that alſo in compounded bodies thoſe Qualities may be (ſometimes at leaſt) produced by the ſame or the like Cauſes? As we ſee, that the reduction of a diaphanous Solid to pouder, produces whiteneſs, whether the comminution happens to Rock-cryſtal or to Venice glaſs, or to Ice: The firſt of which is acknowledged to be a natural and perfectly mixt body; the ſecond a factitious and not onely mixt but decompounded body; and the laſt, for ought appears, an elementary body, or at moſt very ſlightly and imperfectly mixt. And ſo by mingling Air in ſmall portions with a diaphanous Liquor, as we do when we beat ſuch a Liquor into foam, a whiteneſs is produced, as well in pure Water, which is acknowledged to be a ſimple body, as in white Wine, which is reckoned among perfectly mixt bodies.

CHAP.

CHAP. IV.

I Further obſerve, that the Chymiſts Explications do not reach deep and far enough. For *firſt*, moſt of them are not ſufficiently diſtinct and full, ſo as to come home to the particular *Phænomena*, nor often times ſo much as to all the grand ones, that belong to the Hiſtory of the Qualities they pretend to explicate. You will readily believe, that a Chymiſt will not eaſily make out by his Salt, Sulphur, and Mercury, why a Load-ſtone capp'd with ſteel may be made to take up a great deal more Iron, ſometimes more than eight or ten times as much, than if it be immediatly applied to the iron; or why, if one end of the Magnetic Needle is diſpos'd to be attracted by the North-pole, for inſtance, of the Load-ſtone, the other Pole of the Load-ſtone will not attract it but drive it away: or, why a bar or rod of iron, being heated red-hot and cooled perpendi-

cularly, will with its lower end drive away the flower de Luce, or the North-end of a Marriners Needle, which the upper end of the same barr or rod will not repell but draw to it. In short, of above threescore Properties or notable Phænomena of Magnetic Bodies, that some Writers have reckon'd up, I do not remember that any three have been by Chymists so much as attempted to be solved by their three Principles. And even in those Qualities, in whose explications these Principles may more probably than elsewhere pretend to have a place, the Spagyrists accounts are wont to fall so short of being distinct and particular enough, that they use to leave divers considerable *Phænomena* untouch'd, and do but very lamely or slightly explicate the more obvious or familiar. And I have so good an opinion of divers of the embracers of the Spagyrical Theory of Qualities (among whom I have met with very Learned and worthy men) that I think, that if a Quality being pro-

pos'd to them, they were at the ſame time preſented with a good Catalogue of the Phænomena, that they may take, in the Hiſtory of it, as it were with one view, they would plainly perceive that there are more particulars to be accounted for, than at firſt they were aware of; and divers of them ſuch, as may quite diſcourage conſidering men from taking upon them to explain them all by the *Tria prima*, and oblige them to have recourſe to more Catholic and comprehenſive Principles. I know not, whether I may not add on this occaſion, that, methinks, a Chymiſt, who by the help of his *Tria Prima*, takes upon him to interpret that Book of Nature of which the Qualities of bodies make a great part, acts at but a little better rate than he, that ſeeing a great book written in a Cypher, whereof he were acquainted but with three Letters, ſhould undertake to decypher the whole piece. For though 'tis like, he would in many words find one of the Letters of his

short key, and in divers words two of them, and perhaps in some all three; yet, besides that in most of the words wherein the known Letter or Letters may be met with, they may be so blended with other unknown Letters as to keep him from decyphering a good part of those very words, 'tis more than probable, that a great part of the book would consist of words wherein none of his three Letters were to be found.

CHAP. V.

AND this is the *first* account, on which I observe that the Chymical Theory of Qualities does not reach far enough: But there is *another* branch of its deficiency. For even, when the explications seem to come home to the Phænomena, they are not primary, and, if I may so speak, *Fontal* enough. To make this ap-

appear, I ſhall at preſent imploy but theſe two Conſiderations. The *firſt* is, that thoſe ſubſtances themſelves, that Chymiſts call their Principles, are each of them indowed with ſeveral Qualities. Thus *Salt* is a conſiſtent, not a fluid, body; it has its weight, 'tis diſſoluble in water, is either diaphanous or opacous, fixt or volatile, ſapid *or* inſipid; (I ſpeak thus disjunctively, becauſe Chymiſts are not all agreed about theſe things; and it concerns not my Argument, which of the diſputable Qualities be reſolved upon.) And *Sulphur*, according to *them*, is a body fuſible, inflammable, &c. and, according to Experience, is conſiſtent, heavy, &c. So that 'tis by the help of more primary and general Principles, that we muſt explicate ſome of thoſe Qualities, which being found in bodies, ſuppoſed to be perfectly ſimilar or homogeneous, cannot be pretended to be derived in one of them from the other. And to ſay, that 'tis the nature of a Principle to have this or that

Quality, as, for inſtance, of Sulphur to be fuſible, and therefore we are not to exact a Reaſon why it is ſo; though I could ſay much by way of anſwer, I ſhall now only obſerve, that this Argument is grounded but upon a ſuppoſition, and will be of no force, if from the primary affections of bodies one may deduce any good Mechanical Explication of Fuſibility in the general, without neceſſarily ſuppoſing ſuch a Primigeneal Sulphur, as the Chymiſts fancy, or deriving it from thence in other bodies. And indeed, ſince not only Salt-peter, Sea ſalt, Vitriol and Allum, but Salt of Tartar, and the Volatile Salt of Urine are all of them fuſible; I do not well ſee, how Chymiſts can derive the fuſibleneſs even of Salts obtained by their own *analyſis* (ſuch as Salt of Tartar and of Urine) from the participation of the Sulphureous Ingredient; eſpecially ſince, if ſuch an attempt ſhould be made, it would overthrow the *Hypotheſis* of three Simple bodies, whereof they will have all mixt

mixt ones to be compounded; and ſtill 'twould remain to be explicated, upon what account the Principle, that is ſaid to endow the other with ſuch a Quality, comes to be endowed therewith it ſelf. For 'tis plain, that a maſs of Sulphur is not an Atomical or Adamantine body; but conſiſts of a multitude of Corpuſcles of determinate Figures, and connected after a determinate manner: ſo that it may be reaſonably demanded, why ſuch a Convention of particles, rather than many another that does not, conſtitutes a fuſible body.

CHAP. VI.

AND this leads me to a further Conſideration, which makes me look upon the Chymiſts explications as not deep and radical enough; and it is this, that, when they tell us, for inſtance, that the fuſibleneſs of bodies proceeds from Sulphur, in caſe they ſay true, they do but tell us *what* material Ingredient 'tis that being mingled with and diſpers'd through the other parts of a body, makes it apt to melt: But this does not intelligibly declare, *what it is* that makes a portion of matter fuſible, and *how* the ſulphureous Ingredient introduces that diſpoſition into the reſt of the maſs, wherewith 'tis commixt or united. And yet 'tis ſuch explications as theſe, that an inquiſitive Naturaliſt chiefly looks after, and which I therefore call *Philoſophical*. And to ſhew, that there may be more Fontal explications, I ſhall only ob-

obſerve, that, not to wander from our preſent inſtance, Sulphur it ſelf is fuſible. And therefore, as I lately intimated, Fuſibility, which is not the Quality of one Atome, or Particle, but of an Aggregate of Particles, ought it ſelf to be accounted for in that Principle, before the Fuſibleneſs of all other bodies be derived from it. And 'twill in the following notes appear, that in *Sulphur* it ſelf that Quality may be probably deduced from the convention of Corpuſcles of determinate ſhapes and ſizes, contexed or connected after a convenient manner. And if either nature, or art, or chance, ſhould bring together particles endowed with the like Mechanical Affections, and aſſociate them after the like manner, the reſulting body would be fuſible, though the component particles had never been parts of the Chymiſts primordial ſulphur: And ſuch particles ſo convening might perhaps have made Sulphur it ſelf, though before there had been no ſuch body in the world.

world. And what I say to those Chymists, that make the sulphureous Ingredient the cause of fusibility, may easily, *mutatis mutandis*, be applied to *their* Hypothesis, that rather ascribe that quality to the Mercurial or the Saline Principle, and consequently cannot give a rational account of the fusibility of Sulphur. And therefore though I readily allow (as I shall have afterwards occasion to declare) that Sulphur, or an other of the *tria prima*, may be met with, and even abound in several bodies endowed with the quality that is attributed to their participation of that Principle; yet that this may be no certain sign that the propos'd Quality must flow from that Ingredient, you may perhaps be assisted to discern by this illustration, That if Tin be duly mixt with Copper or Gold, or, as I have tried, with Silver or Iron, it will make them very brittle; and it is also an Ingredient of divers other bodies that are likewise brittle, as blew, green, white, and otherwise colour'd, Amels,

which

which are usually made of calcin'd Tin (which the Tradesmen call *Puttee*,) colliquated with the Ingredients of Crystal-glass and some small portion of Mineral pigment. But though in all the above-named brittle bodies, Tin be a considerable Ingredient; yet 'twere very unadvised to affirm, that Brittleness in general proceeds from Tin. For provided the solid parts of consistent bodies touch one another but according to small portions of their surfaces, and be not implicated by their contexture, the Metalline or other Composition may be brittle, though there be no Tin at all in it. And in effect, the materials of glass being brought to fusion will compose a brittle body, as well when there is no Puttee colliquated with them, as when there is. Calcin'd Lead by the action of the fire may be melted into a brittle mass, and even into transparent Glass, without the help of Tin or any other additament. And I need not add, that there are a multitude of other bodies, that cannot be pretended

ed to owe their brittleneſs to any participation of Tin, of which they have no need, if the matter they conſiſt of wants not the requiſite Mechanical Diſpoſitions.

And here I ſhall venture to add, that the way employed by the Chymiſts, as well as the Peripateticks, of accounting for things by the Ingredients, whether Elements, Principles, or other bodies, that they ſuppoſe them to conſiſt of, will often fruſtrate the Naturaliſts expectation of events, which may frequently prove differing from what he promis'd himſelf, upon the Conſideration of the Qualities of each Ingredient. For the enſuing Notes contain divers Inſtances, wherein there emerges a new Quality differing from, or even contrary to, any that is conſpicuous in the Ingredients; as two tranſparent bodies may make an opacous mixture, a yellow body and a blew, one that is green, two malleable bodies, a brittle one, two actually cold bodies, a hot one,

one, two fluid bodies, a consistent one, &c. And as this way of judging by material Principles hinders the foreknowledg of Events from being certain; so it much more hinders the assignation of Causes from being satisfactory; so that perhaps some would not think it very rash to say, that those who judg of all mixt bodies as Apothecaries do of Medicines, barely by the Qualities and Proportions of the Ingredients (such as among the *Aristotelians* are the four Elements, and among the Chymists the *tria prima*,) do, as if one should pretend to give an account of the Phænomena and operations of Clocks and Watches, and their Diversities by this, That some are made of brass wheels, some of iron, some have plain ungilt wheels, others of wheels overlaid with Gold, some furnished with gutstrings, others with little chains, &c. and that therefore the Qualities and Predominancies of these metalls that make parts of the Watch, ought to have ascribed to them, what indeed

flows

flows from their Coordination and Contrivance.

CHAP. VII.

THE *last* defect I observe in the Chymical Doctrine of Qualities, is, that in many cases it agrees not well with the Phænomena of Nature, and that by one or both of these ways. *First*, there are divers changes of Qualities, wherein one may well expect, that a Chymical Principle should have a great stroak, and yet it does not at all appear to have so. He that considers, what great operations divers of the Hermeticks ascribe to this or that Hypostatical Principle, and how many Qualities according to them must from it be derived, can scarce do other than expect, that a great change as to those Qualities happening in a mixt body, should at least be accompany'd with some notable action *of*, or alteration *in* the Prin-

Principle. And yet I have met with many inſtances, wherein Qualities are produced, or aboliſhed, or very much altered, without any manifeſt introduction, expulſion, or conſiderable change of the Principle, whereon *that* Quality is ſaid to depend, or perhaps of either of the two *others*: As when a piece of fine ſilver, that having been neald in the fire, and ſuffer'd to cool leiſurely, is very flexible, is made ſtiff and hard to bend, barely by a few ſtroaks of a hammer. And a ſtring of a Lute acquires or loſes a ſympathy, as they call it, with another ſtring of the ſame or another Inſtrument, barely by being either ſtretched ſo as to make an Uniſon with it, or ſcrew'd up or let down beyond or beneath that degree of Tenſion.

To multiply inſtances of this kind would be to anticipate thoſe, you will hereafter meet with in their due places. And therefore I ſhall paſs on from the firſt ſort of *Phænomena*, that favour not the Chymical Hypotheſis about

about Qualities, to the other which consists of those, wherein either that does not happen which according to their Hypothesis ought to happen, or the contrary happens to what according to their Hypothesis may justly be expected. Of this you will meet with instances hereafter; I shall now trouble you but with one, the better to declare my meaning. 'Tis not unknown to those Chymists, that work much in Silver and in Copper, that the former will endure Ignition and become red-hot in the fire, before it will be brought to fusion; and the latter is yet far more difficult to be melted down than the other; yet if you separately dissolve those two metalls in *Aqua fortis*, and by evaporation reduce them to Crystalls, these will be brought to fusion in a very little time, and with a very moderate Heat, without breaking the glasses that contain them. If you ask a vulgar Chymist the cause of this facility of fusion, he will probably tell you without scruple, that 'tis from

from the saline parts of the *Aqua fortis*, which, being imbodied in the metals and of a very fusible nature, impart that easiness of fusion to the metals they are mixt with. According to which plausible explication one might well expect, that, if the saline Corpuscles were exquisitly mingled with Tin, they would make it far more fusible than of it self it is. And yet, as I have elsewhere noted, when I put Tin into a convenient quantity of *Aqua fortis*, the metal being corroded, subsided, as is usual, in the form of whites of eggs, which being well dried, the Tinn was so far from being grown more fusible by the addition of the saline particles of the *Menstruum*, that, whereas 'tis known that simple Tin will melt long before it come to be red-hot, this prepar'd Tin would endure for a good while not only a thorow ignition, but the blast of a pair of double bellows, (which we usually imploy'd to melt Silver and Copper it self,) without being at all brought to fusion. And

as for those Spagyrists that admit, as most of them are granted to do, that all kinds of metals may be turned into Gold by a very small proportion of what they call the Philosophers *Elixir*, one may I think shew them from their own concessions, that divers Qualities may be changed even in such constant bodies as Metals, without the addition of any considerable proportion of the simple Ingredients, to which they are wont to ascribe those Qualities; provided the Agent, (as an efficient rather than as a material Cause,) be able to make a great change in the Mechanical affections of the parts whereof the metal it acts on is made up. Thus if we suppose a pound of Silver, a pound of Lead, and a pound of Iron to be transmuted into Gold, each by a grain of the powder of projection, this tinging powder, as a material Cause is inconsiderable, by reason of the smallness of its bulk, and as an efficient cause it works differing and even contrary effects, according to the dis-

position,

position, wherein it finds the metal to be transmuted, and the changes it produces in the constituent Texture of it. Thus it brings Quick-silver to be fixt, which it was not before, and deprives it of the Fluidity which it had before; it brings Silver to be indissolvable in *Aqua fortis*, which readily dissolved it before, and dissoluble in *Aqua Regis*, which before would not touch it; and which is very considerable to our present purpose, whereas it makes Iron much more fusible than *Mars*, it makes Lead much less fusible than whilest it retained its pristine form, since *Saturn* melts ere it come to ignition, which Gold requires to bring it to fusion. But this is proposed only as an Argument *ad hominem*, till the Truth of the transmutation of metals into Gold, by way of projection, be sufficiently proved, and the circumstances and phænomena of it particularly declared.

I must not forget to take notice, that some learned modern Chymists would be thought to explicate divers

of the Changes that happen to Bodies in point of Odours, Colours, &c. by saying that in such alterations the Sulphur or other Hypostatical Principle is *intraverted* or *extraverted*, or, as others speak, *inverted*. But I confess, to me these seem to be rather new terms then real explications. For, to omit divers of the Arguments mentioned in this present Treatise, that may be applied to this way of solving the Phænomena of Qualities, one may justly object, that the supposed Extraversion or Intraversion of Sulphur can by no means reach to give an account of so great a variety of Odours, Colours, and other Qualities as may be found in the changed portions of matter we are speaking of. And which is more, what they call by these and the like names, cannot be done without Local motion transposing the particles of the matter, and consequently producing in it a change of Texture, which is the very thing we would infer, and which being supposed, we may grant Sulphur to be oftentimes

times actually present in the altered Bodies, without allowing it to be always necessary to produce the alterations in them, since Corpuscles so condition'd and contex'd would perform such Effects, whether Sulphur, as such, did, or did not, make up the subject-matter of the Change.

And now I shall conclude, and partly recapitulate what has been delivered in this and the two foregoing Chapters, with this summary consideration, That the Chymist's Salt, Sulphur and Mercury themselves are not the first and most simple Principles of Bodies, but rather primary Concretions of Corpuscles or Particles more simple than they, as being endowed only with the first, or most radical (if I may so speak) and most Catholick Affections of simple Bodies, namely Bulk, Shape, and Motion, or Rest; by the different Conventions or Goalitions of which minutest portions of matter are made those differing Concretions that Chymists name Salt, Sulphur and

Mercury. And to this Doctrine it will be consonant, that several Effects of this or that Spagyrical Principle need not be derived from Salt, for instance, or Sulphur as such, but may be explained by the help of some of those Corpuscles that I have lately call'd more Simple and Radical; and such Explications being more simple and Mechanical, may be thought upon that score more fundamental and satisfactory.

CHAP. VIII.

I Know it may be objected in favour of the Chymists, that as their Hypostatical Principles, Salt, Sulphur and Mercury, are but three, so the Corpuscularian Principles are but very few; and the chief of them *Bulk*, *Size*, and *Motion*, are but three neither; so that it appears not why the Chymical Principles should be more

more barren than the Mechanical. To which allegation I anſwer, that, beſides that theſe laſt nam'd Principles are more numerous, as taking in the Poſture, Order, and Scituation, the Reſt, and, above all, the almoſt infinitely diverſifiable Contextures of the ſmall parts, and the thence reſulting ſtructures of particular bodies, and fabrick of the world: Beſides this, I ſay, each of the three Mechanical Principles, ſpecified in the objection, though but one in name, is equivalent to many in effect; as *Figure*, for inſtance, comprehends not only Triangles, Squares, Rhombuſſes, Rhomboïds, Trapezions, and a multitude of Polygons, whether ordinate or irregular; but, beſides Cubes, Priſmes, Cones, Spheres, Cylinders, Pyramids, and other Solids of known Denominations, a ſcarce numerable multitude of hooked, branched, Eel-like, ſcrew-like, and other irregular bodies; whereof though theſe, and ſome others, have diſtinct appellations, yet the greateſt

part are nameless; so that it need be no wonder, that I should make the Mechanical Principles so much more fertile, that is, applicable to the production and explication of a far greater number of *Phænomena*, than the *Chymical*; which, whilest they are considered but as similar bodies, that are Ingredients of mixt and compounded ones, are chiefly variable but by the greater or lesser quantity that is employed by Nature or Art to make up the mixt body. And Painters observe, that Black and White, though mixt in differing Proportions, will still make but lighter and darker grays. And if it be said, that these Ingredients, by the Texture resulting from their mixtures, may acquire Qualities that neither of them had before; I shall answer, that, to alledge this, is in effect to confess, that they must take in the *Mechanical* Principles, (for to them belongs the Texture or Structure of bodies) to assist the *Chymical* ones. And on this occasion, to borrow an illustration

from

from our unpublished *Dialogue of the Requisites of a good Hypothesis*, I shall add, that a Chymist that should pretend, that because his three Principles are as many as those of the Corpuscularians, they are as sufficient as these to give an account of the Book of Nature, methinks, I say, he would do like a man that should pretend, that with four and twenty words he would make up a language as well as others can with the four and twenty Letters of the Alphabet, because he had as many words already formed, as they had of bare Letters; not considering that instead of the small number of variations that can be made of his words by Prepositions and Terminations, the Letters of the Alphabet being variously combined, placed and reiterated, can be easily made to compose not only his four and twenty words, with their variations, but as many others as a whole language contains.

CHAP.

CHAP. IX.

NOtwithstanding all that I have been obliged to say to the Disadvantage of the Chymical Principles, in reference to the Explication of Qualities, I would not be thought to grant, that the *Peripateticks* have reason to triumph, as if their four Elements afforded a better Theory of Qualities. For, if I had, together with leisure enough to perform such a Task, any obligation to undertake it, I presume, it would not be difficult to shew, that the *Aristotelian* Doctrine about particular Qualities is liable to some of the same Objections with the Chymical, and to some others no less considerable; and that, to derive all the *Phænomena* their Doctrine ought to solve from *Substantial Forms* and *real Qualities Elementary*, is to impose on us a Theory more barren and precarious than that of the Spagyrists.

That

That to derive the particular Qualities of bodies from those Substantial Forms, whence the Schools would have them to flow, is but an insufficient and unfit way of accounting for them, may appear by this, that *Substantial Forms* themselves are things, whose existence many Learned Philosophers deny, whose Theory many of them think Incomprehensible, and the most Candid and Judicious of the *Peripateticks* themselves confess it to be very abstruse; so that from such doubtful and obscure Principles we can hardly expect clear Explications of the nature and *Phænomena* of Qualities; not to urge, that the *Aristotelian* Definitions, both of Qualities in general, and of divers of the more familiar Qualities in particular, as Heat, Cold, Moisture, Diaphaneity, &c. are far enough from being clear and well framed, as we elsewhere have occasion to shew.

Another thing, which makes the Scholastic Doctrine of Qualities unsatisfactory, is, that it seldom so much

as attempts to teach the Manner how the Qualities themſelves and their Effects or Operations are produced. Of this you may elſewhere find an Inſtance given in the Quality that is wont to be firſt in the liſt, viz that of *Heat*, which though it may intelligibly and probably be explicated by the Corpuſcular Hypotheſis, yet in the *Peripatetic* account that is given of it, is both too queſtionable and too ſuperficial to give much Content to a Rational Inquirer. And indeed to ſay, that a *Subſtantial Form* (as that of the *Fire*) acts by a Quality (call'd Heat) whoſe Nature 'tis to produce ſuch an effect (as to ſoften Wax or harden Clay) ſeems to be no other in ſubſtance, than to ſay, that it produces ſuch an effect by ſome power it has to produce it. But what that power is, and how it operates, is that, which, though we moſt deſire to know, we are left to ſeek. But to proſecute the Imperfections of the *Peripatetick Hypotheſis*, were to intrench upon another diſcourſe, where they are more fully

fully laid open. And therefore I ſhall now but lightly glance upon a couple of imperfections, that more particularly relate to the Doctrine of Qualities.

And firſt I do not think it a Convincing Argument that is wont to be imployed by the *Ariſtotelians* for their *Elements*, as well as by the *Chymiſts* for their *Principles*, that, becauſe this or that Quality, which they aſcribe to an Element or a Principle, is found in this or that body, which they call mixt, therefore it muſt owe that Quality to the participation of that Principle or Element. For, the ſame Texture of parts or other modification of matter may produce the like Quality in the more ſimple and the more compounded body, and they may both ſeparately derive it from the ſame Cauſe, and not one from the Participation of the other. So Water and Earth and Metals and Stones, &c. are heavy upon the account of the common Cauſe of Gravity, and not becauſe the reſt partake of

of the Earth; as may appear in Elementary water, which is as simple a body as it, and yet is heavy: So water and oil, and exactly deflegm'd Spirit of Wine, and Mercury, and also Metals and Glass of Antimony, and Minium or calcin'd Lead, whilest these three are in fusion are fluid, being made so by the variously determined motions of their minute parts and other Causes of Fluidity, and not by the participation of water, since the arid *Calces* of Lead and Antimony are not like to have retained in the fire so volatile a liquor as water, and since Fluidity is a Quality that Mercury enjoys in a more durable manner than Water it self: For that metalline liquor, as also Spirit of Wine well Rectified, will not be brought to freeze with the highest degree of Cold of our sharpest winters, though a far less degree of Cold would make water cease to be fluid and turn it into Ice.

To this I shall only add (in the second place,) that 'tis not unpleasant

to

to ſee, how arbitrarily the *Peripateticks* derive the Qualities of bodies from their four Elements, as if, to give an inſtance in the lately named Quality, *Liquidity*, you ſhew them exactly deflegmed Spirit of Wine, and ask them, whence it has its great Fluidneſs, they will tell you from water, which yet is far leſs fluid than it, and this ſpirit of wine it ſelf is much leſs ſo than the flame into which the ſpirit of wine is eaſily reſoluble. But if you ask, whence it becomes totally inflammable, they muſt tell you, from the fire; and yet the whole body, at leaſt as far as ſenſe can diſcover, is fluid, and the whole body becomes flame, (and then is moſt fluid of all;) ſo that fire and water as contrary as they make them, muſt both be by vaſt odds predominant in the ſame body. This ſpirit of wine alſo, being a liquor whoſe leaſt parts that are ſenſible are actually heavy, and compoſe a Liquor which is ſeven or eight hundred times as heavy as Air of the ſame bulk, which yet experience

ſhews

shews not to be devoid of weight, must be supposed to abound with Earthy particles, and yet this spirituous liquor may in a trice become Flame, which they would have to be the lightest body in the world.

But, to enlarge on this subject, would be to forget, that the design of this Tract engages me to deal not with the *Peripatetic* School, but the *Spagyrical*. To which I shall therefore return, and give you this advertisement about it, that what I have hitherto objected is meant against the more common and received Doctrine about the Material Principles of bodies reputed mixt, as 'tis wont by vulgar Chymists to be applied to the rendring an account of the Qualities of substances Corporeal; and therefore I pretend not, that the past objections should conclude against other Chymical Theories than that which I was concerned to question. And if *adept* Philosophers, (supposing there be such) or any

any other more than ordinarily Intelligent Spagyriſts, ſhall propoſe any particular Hypotheſes, differing from thoſe that I have queſtioned, as their Doctrine and Reaſons are not yet known to me; ſo I pretend not that the paſt Arguments ſhould conclude againſt them, and am willing to think, that Perſons advantaged with ſuch peculiar opportunities to dive into the Myſteries of Nature, will be able to give us, if they ſhall pleaſe, a far better account of the Qualities of bodies than what is wont to be propoſed by the generality of Chymiſts.

Thus, dear *Pyrophilus*, I have laid before you ſome of the chief Imperfections I have obſerved in the vulgar Chymiſts Doctrine of Qualities, and conſequently I have given you ſome of the chief Reaſons that hinder me from acquieſcing in it. And as my objections are not taken from the Scholaſtical ſubtleties nor the doubtful ſpeculations of the Peripateticks or other Adverſaries of the

Hermetick Philosophy, but from the nature of things and from Chymical experiments themselves; so I hope, if any of your Spagyrical friends have a minde to convince me, he will attempt to doe it by the most proper way, which is, by actually giving us clear and particular explications, at least of the grand *Phænomena* of Qualities; which, if he shall do, he will find me very ready to acquiesce in a Truth that comes usher'd in, and endear'd by so acceptable and useful a thing, as a Philosophical Theory of Qualities.

FINIS.

REFLECTIONS

UPON THE

Hypotheſis

OF

ALCALI and ACIDUM.

By the Honourable

ROBERT BOYLE Eſq;

Fellow of the *R. Society.*

LONDON,

Printed by *E. Fleſher*, for *R. Davis* Bookſeller in *Oxford.* 1675.

THough the following Diſcourſe was at firſt written by way of *Appendix* to the Treatiſe of the Imperfection of the Chymical Doctrine of Qualities; yet the bulk of it, ſwelling beyond what was foreſeen, made it ſeem expedient to publiſh it as a Tract by it ſelf.

REFLECTIONS

UPON THE

Hypotheſis

OF

Alcali and Acidum.

CHAP. I.

I Preſume, it will not be difficult to diſcern, that much of what has been ſaid about the *Imperfection of the vulgar Chymical Doctrine concerning Qualities*, may with eaſie variations be applied to ſome other *Hypotheſes* that are of kin to that Doctrine, and particularly to their

Theory, that would derive both the Qualities of Bodies and the rest of the *Phænomena* of Nature from what they call *Acidum* and *Alcali*. For though these two differences may be met with in a great number and variety of bodies, and consequently the Consideration of them may frequently enough be of good use, (especially to Spagyrists, and Physitians, when they are conversant about the secondary and (if I may so call them) Chymical Causes and Operations of divers mixt bodies;) yet I confess I cannot acquiesce in this *Hypothesis* of *Alkali* and *Acidum*, in the latitude, wherein I find it urged and applied by the Admirers of it, as if it could be usefully substituted in the place of *Matter* and *Motion*.

The *Hypothesis*, being in a sort subordinate to that of the *tria prima*, in ascribing to *two contrary saline Principles* what vulgar Chymists do to their *Salt*, *Sulphur*, and *Mercury*; most of the objections we have made against the vulgar Chymical Doctrine, may,

may, as I lately intimated, be applied, by a little variation, to this, and therefore I ſhall need but to touch upon the main things that keep me from acquieſcing in this *Hypotheſis*.

CHAP. II.

AND *firſt*, it ſeems precarious to affirm, that in all bodies, or even in all the ſenſible parts of mixts, *Acid* and *Alcalizate* parts are found; there not having been, that I know, any Experimental Induction made of particulars any thing near numerous enough to make out ſo great an aſſertion, and in divers bodies, wherein Experience is vouch'd for the inexiſtence of theſe Principles, that Inexiſtence is indeed proved not by direct and clear experience, but upon a ſuppoſition, that ſuch and ſuch effects flow from the operations of the aſſumed Principles.

Some Spagyriſts, when they ſee *Aqua fortis* diſſolve Filings of Copper, conclude from thence, that the Acid ſpirits of the *Menſtruum* meet in the metal with an *Alcali* upon which they work; which is but an unſafe way of arguing, ſince good Spirit of Urin, which they take to be a volatile *Alcali*, and which will make a great Conflict with *Aqua fortis*, will, as I have elſewhere noted, diſſolve filings of Copper both readily enough and more genuinly than the Acid liquor is wont to do. So when they ſee the Magiſtery of Pearl or Coral, made by dropping oil of Tartar into the ſolutions of thoſe bodies made with ſpirit of Vinegar, they aſcribe the Precipitation to the fixt *Alcali* of the *Tartar*, that mortifies the Acidity of the ſpirit of Vinegar; whereas the Precipitation would no leſs inſue, if, inſtead of Alcalizat oil of Tartar, we imploy that highly acid liquor which they call *Oleum Sulphuris per Campanam.*

I think also it may be doubted, whether those, I reason with, are so certain as they suppose, that at least when they can manifestly discover an Acid, for instance, in a body, the operation of that body upon another, which they judge to abound with an *Alcali*, must be the effect of a Conflict between those two jarring Principles, or, if I may so call them, Duellists. For an Acid body may do many things, not simply as an acid, but on the score of a Texture or modification, which endows it with other Qualities as well as Acidity, whose being associated with those other Qualities in some cases may be but accidental to the effect to be produced; since by one or more of these other Qualities the body may act in cases, where Prejudice may make a Chymist consider nothing but Acidity. Thus when some Chymists see an acid *Menstruum*, as *Aqua fortis*, spirit of Salt, oil of Vitriol, &c. dissolve Iron, they presently ascribe the effect to an Acidity of the liquors, whereas well dephlegmed

Urinous Spirits, which they hold to have a great Antipathy to Acids, will, as I have tried in ſome of them, readily enough diſſolve crude Iron even in the Cold. And on the other ſide, *Mercury* will not work on the filings of Iron, though this be ſo open a metal that even weak liquors will do it; and yet if one ſhould urge, that Quickſilver readily diſſolves Gold in Amalgamation, he may expect to be told, according to their Doctrine, that *Mercury* has in it an occult acid, by which it performs the ſolution; whereas it ſeems much more probable, that Mercury has Corpuſcles of ſuch a ſhape and ſize as fit them to inſinuate themſelves into the Commenſurate Pores they meet with in Gold, but make them unfit to enter readily the Pores of Iron, to which Nature has not made them congruous; as on the other ſide the ſaline Corpuſcles of *Aqua fortis* will eaſily find admiſſion into the Pores of Iron, but not into thoſe of Gold, to which they do not correſpond as they do to the others.

And

And when a knife, whoſe blade is touched with a Load-ſtone, cuts bread and takes up filings of Iron, it does neither of them upon the ſcore of *Alcali* and *Acidum*, but the one upon the viſible ſhape and the ſtiffneſs of the blade, and the other upon the latent Contrivance or change of Texture produced by the operation of the Load-ſtone in the particles that compoſe the Steel.

This may perhaps be farther illuſtrated by adding, that when blew *Vitriol*, being beaten and finely ſearced, makes a white pouder, that whiteneſs is a quality which the pouder has not as being of a Vitriolate Nature. For Rock-Cryſtal or Venice-glaſs being finely beaten will have the ſame operation on the Eye, but it proceeds from the tranſparency of the body and the minuteneſs, multitude and confus'd ſcituation of the Corpuſcles that make up the Pouder. And therefore, if other bodies be brought by Comminution into parts endow'd with ſuch Mechanical

cal affections, as we have named; these aggregates will act upon the organs of Sight as white bodies.

CHAP. III.

AND this leads me to another Exception against the *Hypothesis* of the Duellists, which is, that the Framers of it seem *arbitrarily* to have assigned Provinces or Offices to each of their two Principles, as the *Chymists* do to each of their *tria prima*, and the *Peripateticks* to each of their *Four Elements*. For 'tis not enough to Say, that an *Acid*, for instance, as such, performs these things, and an *Alkali* so many others, that they divide the Operations and *Phænomena* of nature, or at least (as some, more cautious, are content to say) of mixt bodies between them; since Assertions of such great moment ought not to be advanc'd or received without suf-

ſufficient Proof. And perhaps the very diſtribution of Salts into *Acids* and *Alcalies* hath ſomewhat of arbitrary in it, ſince others may, without aſſuming much more, take the freedom to diſtribute them otherwiſe, there being not only ſeveral things wherein Acids and Alcalies agree, but alſo ſeveral things wherein Salts of the ſame denomination widely differ. As, for Inſtance, ſome Alkalies, according to thoſe I reaſon with, are, like ſalt of Tartar, fixt, and will endure the violence of the fire; others, like ſalt of Urin or Harts-horn, are exceedingly fugitive, and will be driven up with a ſcarce ſenſible degree of Heat; ſome, as ſalt of Tartar, will precipitate the ſolution of Sublimate into an Orange-tawny; others, as ſpirit of Blood and Harts-horn, precipitate ſuch a ſolution into a milky ſubſtance. Oil of Tartar will very ſlowly operate upon filings of Copper, which Spirit of Urin and Harts-horn will readily diſſolve in the Fire.

And

cal affections, as we have named; these aggregates will act upon the organs of Sight as white bodies.

CHAP. III.

AND this leads me to another Exception against the *Hypothesis* of the Duellists, which is, that the Framers of it seem *arbitrarily* to have assigned Provinces or Offices to each of their two Principles, as the *Chymists* do to each of their *tria prima*, and the *Peripateticks* to each of their *Four Elements*. For 'tis not enough to Say, that an *Acid*, for instance, as such, performs these things, and an *Alkali* so many others, that they divide the Operations and *Phænomena* of nature, or at least (as some, more cautious, are content to say) of mixt bodies between them; since Assertions of such great moment ought not to be advanc'd or received without suf-

ſufficient Proof. And perhaps the very diſtribution of Salts into *Acids* and *Alcalies* hath ſomewhat of arbitrary in it, ſince others may, without aſſuming much more, take the freedom to diſtribute them otherwiſe, there being not only ſeveral things wherein Acids and Alcalies agree, but alſo ſeveral things wherein Salts of the ſame denomination widely differ. As, for Inſtance, ſome Alkalies, according to thoſe I reaſon with, are, like ſalt of Tartar, fixt, and will endure the violence of the fire; others, like ſalt of Urin or Harts-horn, are exceedingly fugitive, and will be driven up with a ſcarce ſenſible degree of Heat; ſome, as ſalt of Tartar, will precipitate the ſolution of Sublimate into an Orange-tawny; others, as ſpirit of Blood and Harts-horn, precipitate ſuch a ſolution into a milky ſubſtance. Oil of Tartar will very ſlowly operate upon filings of Copper, which Spirit of Urin and Harts-horn will readily diſſolve in the Fire.

And

And among *Acids* themselves the difference is no less if not much greater. Some of them will dissolve bodies that others will not, as *Aqua fortis* will dissolve Silver and Mercury, but leave Gold untouched; or as *Aqua Regis*, though made without *Sal Armoniac* that dissolves Gold readily, will dissolve Mercury but scurvily, and Silver not at all. And this may happen, when the *Menstruum* that will not dissolve the body is reputed much stronger than that which does; as dephlegm'd spirit of Vinegar will dissolve Lead, reduc'd to minute parts in the cold; which is an effect that Chymists are not wont to expect from Spirit of Salt. Nay, which is more, one Acid will precipitate what another has dissolved, and contrarily; as spirit of Salt will precipitate Silver out of spirit of Nitre. And I found oil of Vitriol to precipitate bodies of divers kinds, Minerals and others, out of some acid Menstruums, particularly spirit of Vinegar.

To

To this might be added the Properties, peculiar to ſome particular Acids, as that *Spirit of Nitre* or *Aqua fortis* will diſſolve Camphire into an Oil, and coagulate common oil into a conſiſtent and brittle ſubſtance like Tallow; and, though it will both corrode Silver, Copper, Lead, and Mercury, and keep them diſſolved, it will quickly let fall almoſt the whole body of Tin, very ſoon after it has corroded as much as it can of it. By all which, and ſome other like Inſtances, I am induc'd to queſtion, whether the *Acidum* and *Alkali*, we are ſpeaking of, have the ſimplicity that Philoſophy requires in Principles; and ſhall be kept from wondering, if others ſhall think it as free for them to conſtitute other Principles, as 'tis for the Learned men I reaſon with, to pitch upon *Acidum* and *Alkali*.

And ſome perhaps will be bold to ſay, that, ſince the former of thoſe Principles comprehend ſuch a number of bodies, that are, many of them, very differing, and ſome of them directly

contrary

contrary in their operations, it ſeems a ſlight and not Philoſophical Account of their Nature, to define an Acid by its Hoſtility to an Alcali, which (they will ſay) is almoſt as if one ſhould define a *Man* by ſaying, that he is an Animal that is at enmity with the Serpent; or a *Lyon*, that he is a fourfooted beaſt that flies from a Crowing Cock.

CHAP. IV.

BUT although one of the chiefeſt Conditions that Philoſophers may juſtly require in Principles, is, that, being to explain other things, they ſhould be very clear themſelves; yet I do not much wonder, that the Definitions given us of *Acidum* and *Alcali* ſhould be but unaccurate and ſuperficial, ſince I find not, that they have themſelves any clear and determinate Notion or ſure marks, whereby to know them diſtinctly, without which

which Chymists will scarce be able to form clear and setled Notions of them. For to infer, as is usual, that, because a body dissolves another, which is dissoluble by this or that known acid, the Solvent must also be acid; or to conclude, that, if a body precipitates a dissolved metal out of a confessedly acid Menstruum, the Precipitant must be an Alcali, to argue thus, I say, 'tis unsecure; since, not to repeat what I said lately of Copper, I found, that filings of Spelter will be dissolved as well by some Alcalies, (as spirit of Sal Armoniac) as by Acids. And bodies may be precipitated out of acid Menstruums, both by other Acids, and by liquors, where there appears not the least *Alcali*: As I have found, that a solution of Tinglass, made in *Aqua fortis*, would be precipitated both by Spirit of Salt and by common or rain water. And as for the other grand way that Chymists employ, to distinguish Acids and Alcalies, namely by the Heat, Commotion, and bubbles that are excited, upon

upon their being put together, that may be no such certain sign as they presume, they having indeed a dependance upon particular Contextures and other Mechanical affections, that Chymists are not wont to take any notice of. For almost any thing that is fitted variously and vehemently to agitate the minute parts of a body, will produce Heat in it; and so, though water be neither an Acid nor an Alcalizate liquor, yet it would quickly grow very hot, not only with the highly acid Oil of Vitriol, but (as I have more than once purposely tried and found) with the fiery Alcalizat Salt of Tartar. And 'tis to be noted, that neither in the one nor the other of these Incalescent mixtures, there is produced any such visible or audible conflict, as, according to the Doctrine of the Chymists I reason with, one would expect. And as for the production of bubbles, especially if accompanied with a hissing noise, neither is that such a certain sign as Chymists imagine: For the

the production of bubbles is not a neceſſary effect or concomitant of Heat excited by Conflicts, but depends very much upon the peculiar Diſpoſition of Bodies put together to extricate, produce, or intercept particles of Air, (or *Steams*, for the time equivalent to them;) and therefore as Oil of Vitriol, mixt in a due proportion with fair water, may be brought to make the water too hot to be held in ones hand, without exciting bubbles; ſo I have found by trials purpoſely made, that Alcalizat Spirit of Urine drawn from ſome kinds of Quick-lime, being mixt with Oil of Vitriol moderately ſtrong, would produce an intenſe Heat, whileſt it produced either no manifeſt bubbles at all, or ſcarce any, though the Urinous Spirit was ſtrong, and in other Trials operated like an *Alcali*; and although alſo with Spirit of Urin, made *per ſe* the common way, the oil of Vitriol will produce a great hiſſing and a multitude of conſpicuous bubbles.

On the other side I have sometimes, though not so constantly, found, that some Acid Spirits, especially that of Verdigrease made *per se*, would, when poured upon Salt of Tartar, make a Conflict with it, and produce a copious froth, though we observed it not to be accompanied with any manifest Heat. And I elsewhere mention two bodies, upon whose putting together numerous bubbles would, for a long time, and not without noise, be generated, and succeed one another, though I could perceive no Heat at all to accompany this Tumult.

As for the *Taste*, which by many is made a great Touchstone, whereby to know Acids and Alcalies, I consider that there is a multitude of mixt bodies, wherein we can so little discern by the Taste, which of the Principles is Predominant, that this Sense would not oblige one to suspect, much less to conclude, there were one grain of either of them to be found there; such bodies are Diamonds and Rubies, and most

most Gems, besides many ignobler Stones, and Gold and Silver and Mercury, and I know not how many other bodies. On the other side, there are bodies that abound with Acid or Alcalizat Salts, which either have no Taſt, or a quite differing one from that of the Chymical Principle. As though Venice-glaſs be in great part composed of a fixt *Alcali*; yet to the Tongue it is inſipid, and Cryſtalls of Lune and of Lead made with *Aqua fortis*, and containing great ſtore of the Acid particles of the *Menſtruum*, have nothing of Acidity in the mouth, the latter having a ſaccharine ſweetneſs, and the former an extream bitterneſs. And even in Vegetable ſubſtances that have a manifeſt Taſt, 'tis not ſo eaſie to know by that, whether it be the Acid or the Alcalizat Principle that is predominant in them; as in the Eſſential oils of Spices and other Vegetables. And in the groſs Empereumatical Oils of Woods, and even in high Rectified Spirit of Wine,

which therefore some will have to be an Alcalizat liquor, and others list it among Acids, though I did not find it neither to be destroyed or much altered by being put upon Coral or salt of Tartar, as would happen to an acid *Menstruum*, nor yet by being digested with and distilled from sea Salt, as might be probably expected from an Alcalizat one: And among those very bodies which their Tasts perswade Chymists to reckon amongst Acids, one may (according to what I formerly noted) observe so great a difference and variety of relishes, that, perhaps without being too severe, I may say, that if I were to allow Acids to be One Principle, it should be only in some such Metaphysical sense, as that wherein Air is said to be One Body, though it consist of the associated effluviums of a multitude of Corpuscles of very differing Natures, that agree in very little save in their being minute enough to concur to the Composition of a fluid aggregate, consisting

ing of flying parts. But having dwelt longer than I intended on One Objection, 'tis time that I proceed to those that remain.

CHAP. V.

ANother particular, I am unsatisfied with in the *Hypothesis* of *Alcali* and *Acidum*, is, that 'tis in divers cases either needless or useless to explain the *Phænomena* of Qualities, there being several of these produced, destroyed, or altered, where there does not appear any accession, recess, or change of either of those two Principles; as when fluid water by hard beating is turn'd into consistent froth, and when transparent red Coral is, barely by being beaten and sifted finely, changed into a white and opacous powder; and as when a very flexible piece of fine silver being hammer'd is brought to have a brisk spring, and after a while will, instead

of continuing malleable, crack or cleave under the hammer; and as when (to dispatch and omit other instances) a sufficiently thin leaf of Gold, held between the Light and the Eye, appears green.

Another thing (of kin to the former,) that I like not in the Doctrine of *Acidum* and *Alcali*, is, that though the Patrons of it, whilest they would seem to constitute but two Principles, are fain (as I lately intimated) to make I know not how many differing sorts of Acids, besides some variety of Alcalies; *yet* their Principles are too few and narrow to afford any satisfactory explication of the *Phænomena*. For I fear, 'twill be very difficult for them to give a Rational Account of Gravity, Springiness, Light, and Emphatical Colours, Sounds, and some other Qualities that are wont to be called manifest; and much more of several that are confest to be occult, as Electricity, and Magnetism; in which last I see not, how the affirming that there

there is in the Magnet an Acid and an Alcali, and that these two are of contrary Natures, will help to explain, how a Load-stone does, as they speak, attract the same end of a poised needle with one of its Poles, which 'twill drive away with the other, and determine that needle when freely placed, to point North and South, and enable it to communicate by its bare touch the same Properties, and abundance of other strange ones, to another piece of Steel. But I forbear to alledge particular Examples referrable to the several Qualities abovementioned, whether manifest or hidden, because that in great part is already done in our Notes about particular Qualities, in which 'twill appear how little able the employing of *Alcali* and *Acidum* will be to afford us an account of many things. And though I enlarge not here on this objection, yet I take it to be of that importance, that, though there were no other, this were enough to shew that

the Hypothesis that is liable to it, is Insufficient for the explication of Qualities; and therefore 'twill not I presume be thought strange that I add, that, as for those that would extend this narrow Chymical Doctrine to the whole object of Natural Philosophy, they must do more than I expect they will be able before they can make me their Proselyte, there being a multitude of *Phænomena* in nature (divers whereof I elsewhere take notice of in reference to the Chymists Philosophy) in which what *Acidum* and *Alcali* have to do, I confess I do not understand.

CHAP.

CHAP. VI.

THE laſt thing (which comprizes ſeveral others) that ſeems to me a defect in the Doctrine of *Alcali* and *Acidum*, is, that divers if not moſt of thoſe very things that are pretended to be explicated by them, are not ſatisfactorily explicated, ſome things being taken into the explications that are either not fundamental enough or not clearly intelligible, or are chargeable with both thoſe Imperfections.

And firſt I am diſſatisfied with the very fundamental Notion of this Doctrine, namely a ſuppoſed Hoſtility between the tribe of Acids and that of Alkalies, accompanied, if you will have it ſo, with a friendſhip or ſympathy with bodies belonging to the ſame tribe or Family. For I look upon Amity and Enmity as Affections of Intelligent Beings, and I have not

not yet found it explained by any, how those Appetites can be placed in Bodies Inanimate and devoid of knowledge, or of so much as Sense. And I elsewhere endeavour to shew, that what is called Sympathy and Antipathy between such bodies does in great part depend upon the actings of our own Intellect, which, supposing in every body an innate appetite to preserve it self both in a defensive and an offensive way, inclines us to conclude, that that body, which, though designlesly destroys or impairs the state or texture of another body, has an Enmity to it, though perhaps a slight Mechanical change may make bodys, that seem extreamly hostile, seem to agree very well and co-operate to the production of the same effects. As if the acid spirit of Salt and the volatile *Alkali* (as they will have it) that is commonly called Spirit of Urine be put together, they will, after a short though fierce conflict, upon a new contexture unite together

gether into a Salt, little, if at all, differing from Sal Armoniac, in which the two reconciled Principles will amicably join in cooling of water, dissolving some metalline bodys, and producing divers other effects. And so, if upon a strong solution of Salt of Pot-ashes or of Salt of Tartar, good Spirit of Nitre be dropt in a due proportion, after the Heat and Tumult and Ebullition are over, the Acid and the Alkalizat Salts will convene into such a Concretion as Salt-peter, which is taken to be a natural body, either homogeneous, or at least consisting of parts that agree very friendly together, and conspire to constitute the particular kind of Salt that Chymists call Nitre.

But the Sympathy and Antipathy that is said to be betwixt Inanimate bodys, I elsewhere more particularly consider, and therefore I shall now add in the second place, That the Explications made of *Phænomena* according to the Doctrine of *Alcali* and

and *Acidum* do not, in my apprehension, perform what may be justly expected from Philosophical Explications. 'Tis said indeed, that the *Acidum* working on the *Alcali*, or this upon that, produces the effect proposed; but that is only to tell us, what is the Agent that operates, and not the Manner of the operation, or the means and process whereby it produces the effect proposed, and 'tis this *modus* that Inquisitive Naturalists chiefly desire to learn. And if it be said, that it is by the mutual hostility of the Principles that the effect is produced, it may be answered, that besides, that that hostility it self is not, as we have just now observed, a thing clear, if so mucha s Intelligible; this is so general and indeterminate a way of explicating things, as can afford little or no satisfaction to a searching and cautious Naturalist, that considers how very numerous and very various the *Phænomena* of Qualities are.

CHAP.

CHAP. VII.

TO clear up and to countenance what I have been now saying, I shall only take notice of some few obvious Phænomena of one of the most familiar Operations wherein Acidum and Alcali are supposed to be the grand Agents. 'Tis known to the very Boys of Chymists, that *Aqua Regis* will dissolve Gold, Copper, and Mercury, and that with these metals, especially with the second, it will produce an intense degree of heat. If now the Cause of this Heat be demanded, it may be expected, that the Patrons of the Duellists will answer, that 'tis from the action of the Acid salts of the Menstruum upon the Alcali they meet with in the Metalls. But not to mention how many things are here presumed, not proved; nor that I know some Acid Menstruums, and some

ſome much more evidently Alcalizate Bodys than theſe Metals are, which yet do not upon their mixtures produce any ſenſible heat; not, I ſay, to mention theſe, it is eaſie to diſcern, that this anſwer names indeed two ſuppoſed efficients of Heat, but does not explicate or declare *how* theſe Agents produce that Quality, which depends upon a certain vehement and various agitation of the ſingly inſenſible parts of Bodys, whether the Duelliſts, or any other, though very differing, Cauſes put them into a motion ſo modified. And therefore Gold and Copper by bare Concuſſion may be brought to an intenſe degree of heat without the acceſſion of any acid parts to work upon them. But then further, when we are told, that *Aqua Regis* by its Acidity working on the Metalline Alcali makes a diſſolution of the Metal; I am told indeed what they think to be the Agent in this change, but not at all ſatisfied how

how this Agent effects it; for, Copper being a very hard metal, and Gold generally esteemed by Chymists the closest and compactest Body in nature, I would gladly know, by what power and way such weak and probably either brittle or flexible bodys as acid Salts, are enabled with that force to disjoin such solid and closely coherent Corpuscles as make up the visible masses of Copper and Gold, nay, and scatter them with that violence as perhaps to toss up multitudes of them into the air. And since in the dissolution of these Metals there is another Phænomenon to be accounted for, as well as the forcing of the parts asunder, namely the sustentation of the Metal in the Menstruum, the Chymists would have much informed me, if they had well explained, how their Acidum and Alcali is able to sustain and give fluidity to the Corpuscles of the dissolved Metal, which though it be but Cop-

Copper, is nine times as heavy as a bulk of water equal to it, and if it be Gold, is nineteen times heavier than the Liquor that must keep it from sinking; and at least divers times heavier in specie than the Salts, that are mingled with the aqueous parts, can make the Menstruum composed of them both. Whereas Trial has assured me, that, if a piece of Wax or any other such matter be made by less than the hundredth part heavier than an equal bulk of Water, it will, when thoroughly immersed, fall to the bottom and rest there. I might also ask a further Question about these Dissolutions, as why, whereas *Aqua Regis* dissolves Mercury without being much changed in colour by it, Gold retains its own Citrinity or yellowness in the solvent, and the solution of Copper is of a colour, which being greenish-blew is quite differing from that of the metal that affords it, as well as from that of the solvent? And I might

might recruit these with other Queries not impertinent, but that these may suffice (for a sample) on this Occasion, and allow me to conclude this Chapter, by representing One thing which I would gladly recommend and inculcate to you, namely, that *Those Hypotheses do not a little hinder the progress of Humane knowledge that introduce Morals and Politicks into the Explications of Corporeal Nature, where all things are indeed transacted according to Laws Mechanical.*

CHAP. VIII.

I Might eaſily have been more copious in the Inſtances annext to the foregoing Animadverſions, but that, being deſirous to be ſhort as well as clear, I purpoſely declined to make uſe of divers others, that ſeemed proper to be employed, and indeed might ſafely enough have been ſo, becauſe thoſe I have *mentioned*, and eſpecially thoſe, (which make a great part of them) that are Mechanical, are not liable to the ſame exceptions, that I foreſaw might be made to elude the force of the Examples I *paſſed by*. And though I think I could very well make thoſe foreſeen Objections appear groundleſs or unſatisfactory; yet that could ſcarce be done without engaging in Controverſies that would prove more tedious than I judged them neceſſary.

And

And yet, although what I have ſaid in this Excurſion be but a part of what I could ſay, I would not be thought to have forgot what I intimated at the beginning of it. For though the Reaſons I alledged keep me from acquieſcing in the Doctrine of *Alcali* and *Acidum*, as 'tis propoſed under the notion of a Philoſophical *Hypotheſis*, ſuch as the Carteſian or Epicurean, which are each of them alledged by their embracers to be Mechanical, and of a very Catholick extent; yet I deny not, that the Conſideration of the Duelliſts (or the two jarring Principles of *Alcali* and *Acidum*) may be of good uſe to Spagyriſts and Phyſitians, as I elſewhere further declare. Nor do I pretend by the paſt diſcourſe that queſtions one Doctrine of the Chymiſts, to beget a general contempt of their Notions, and much leſs of their Experiments. For the operations of Chymiſtry may be miſapplied by the er-

roneous Reaſonings of the Artiſts without ceaſing to be themſelves things of great uſe, as being applicable as well to the Diſcovery or Confirmation of ſolid Theories, as the production of new *Phænomena*, and beneficial effects. And though I think, that many *Notions* of *Paracelſus* and *Helmont* and ſome other Eminent Spagyriſts are unſolid, and not worthy the veneration that their Admirers cheriſh for them; yet divers of the *Experiments*, which either are alledged to favour theſe notions, or on other accounts are to be met with among the followers of theſe men, deſerve the curioſity if not the eſteem of the Induſtrious Inquirers into Natures Myſteries. And looking upon Chymiſtry in groſs as a Diſcipline ſubordinate to Phyſiques, even Mechanical Philoſophers may juſtly, in my opinion, think favourably of it, ſince, whatever Imperfections, or, if they pleaſe, Extravagancies there may be in the

the Principles and Explications of *Paracelſus* or other Leading Artiſts, theſe faults of the Theorical part may be ſufficiently compenſated by the Utilities that may be derived from the Practical part. And this I am the rather induced to ſay, becauſe the Experiments, that Chymiſtry furniſhes, may much aſſiſt a Naturaliſt to rectifie the Erroneous Theories that oftentimes accompany Them, and even thoſe (Miſtakes) that are endeavour'd to be evinced by them.

And (to conclude) Chymiſtry ſeems to deal with men in reference to Notions, as it does in reference to Metals, aſſiſting wary men to detect the Errors, unto which it may have miſled the unwary: For the ſame Art that has taught ſome to impoſe on others, (and perhaps themſelves firſt) by blanching Copper, imitating Gold, &c. does alſo ſupply Say-maſters and

and Refiners, with the Means, by the Cupel, Cements, *Aqua fortis*, &c. to examine, whether Coins be true or falſe, and diſcover Adulterate Gold and Silver to be Counterfeit.

FINIS.

EXPERIMENTS,

AND

NOTES,

About

The Mechanical Origine

AND

PRODUCTION

OF

VOLATILITY.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

LONDON,
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About the

EXPERIMENTS

AND

NOTES

Relating to CHYMICAL

Qualities.

WHen, after I had gone through the common Operations of Chymistry, I began to make some serious Reflections on them, I thought 'twas pity, that Instruments that might prove so serviceable to the advancement of Natural Philosophy, should not be more studiously and skilfully made use of to so good a a pur-

a purpoſe. I ſaw indeed, that divers of the Chymiſts had by a diligent and laudable employment of their pains and induſtry, obtain'd divers Productions, and lighted on ſeveral Phænomena conſiderable in their kind, and indeed more numerous, than, the narrowneſs and ſterility of their Principles conſider'd, could well be expected. But I obſerved too, that the generality of thoſe that buſie themſelves about Chymical Operations; ſome becauſe they practiſe Phyſick; and others becauſe they either much wanted, or greedily coveted money, aimed in their Trials but at the Preparation of good Medicines for the humane body, or to diſcover the ways of curing the Diſeaſes or Imperfections of Metals, without referring their Trials to the advancement of Natural Philoſophy in general; of which moſt of the Alchymiſts ſeem to have been ſo incurious, that not onely they did not inſtitute Experiments for

for that purpoſe, but overlookt and deſpis'd thoſe undeſign'd ones that occurr'd to them whilſt they were proſecuting a preparation of a Medicine, or a Tranſmutation of Metals. The ſenſe I had of this too general omiſſion of the Chymiſts, tempted me ſometimes to try, whether I could do any thing towards the repairing of it by handling Chymiſtry, not as a Phyſician, or an Alchymiſt, but as a meer Naturaliſt, and ſo by applying Chymical Operations to Philoſophical purpoſes. And in purſuance of theſe thoughts, I remember I drew up a Scheme of what I ventur'd to call a *Chymia Philoſophica*, not out of any affectation of a ſplendid Title, but to intimate, that the Chymical Operations, there treated of, were not directed to the uſual ſcopes of Phyſicians, or Tranſmuters of Metals, but partly to illuſtrate or confirm ſome Philoſophical Theories by ſuch Operations; and partly to explicate thoſe Opera-

tions by the help of ſuch Theories.

But before I had made any great progreſs in the purſuit of this deſign, the fatal Peſtilence that raged in *London*, and in many other parts of *England*, in the years 1664 and 65, obliging me among the reſt to make ſeveral removes; which put me upon taking new meaſures, and engaging me in other employments of my time, made me ſo long neglect the Papers I had drawn up, that at laſt I knew not where to finde them, (though I hope they are not yet miſlaid beyond recovery,) which I was the leſs troubled at, becauſe the great difficulties, to be met with in ſuch an undertaking, did not a little diſcourage me, ſuch a Task requiring as well as deſerving a Perſon better furniſhed, than I had reaſon to think my ſelf, with Abilities, Leiſure, Chymical Experiments, and Conveniences, to try as many more as ſhould appear needful. But yet

to

to break the Ice for any that may hereafter think fit to ſet upon ſuch a Work, or to ſhorten my own Labour, if I ſhould ſee cauſe to reſume it my ſelf, I was content to throw in among my Notes about other Particular Qualities, ſome Experiments and Obſervations about ſome of thoſe, that I have elſewhere call'd *Chymical Qualities*, becauſe 'tis chiefly by the Operations of Chymiſts, that men have been induced to take ſpecial notice of them. Of theſe Notes I have aſſigned to ſome Qualities more, and to ſome fewer, as either the nature or importance of the Subject ſeemed to require, or my Leiſure and other Circumſtances would permit. And though I have not here handled the Subjects they belonged to, as if I intended ſuch a *Chymia Philoſophica* as I lately mentioned, becauſe my deſign did not make it neceſſary, but did perhaps make it impertinent for me to do ſo, yet in ſome of the larger

Notes

Notes about *Volatility* and *Fixtneſs*, and eſpecially about *Precipitation*, I have given ſome little *Specimens* of the Theorical part of a Philoſophical Account of thoſe Qualities or Operations, that I hope will not be wholly uſeleſs. I know, it may be objected, that I ſhould have employed for Inſtances ſome more conſiderable Experiments, if not *Arcana*; but though poſſibly I am not altogether unfurniſhed with ſuch, yet aiming rather to promote Philoſophy, than appear a Poſſeſſor of elaborate Proceſſes, I declined ſeveral Experiments that required either more skill, or more time, or more expence than could be well expected from moſt Readers, and choſe rather to employ ſuch Experiments as may be more eaſily or cheaply tried, and, which is mainly to be conſider'd, being more ſimple, are more clearly intelligible, and more fit to have Notions and Theories built upon them; eſpecially conſidering, that

that the Doctrine of Qualities being it ſelf converſant about ſome of the Rudimental parts, if I may ſo call them, of Natural Philoſophy, it ſeemed unfit to employ intricate Experiments, and whoſe Cauſes were liable to many diſputes, to ſettle a Theory of them. In ſhort, my deſign being to hold a Taper not ſo much to Chymiſts as to the Naturaliſts, 'twas fit I ſhould be leſs ſolicitous to gratifie the former than to inform the later.

FINIS.

EXPERIMENTS,
AND
NOTES,
About
The Mechanical Origine
AND
PRODUCTION
OF
VOLATILITY.

CHAP. I.

AS far as I have yet obſerved, the Qualifications or Attributes, on whoſe account a portion of matter is found to be *Volatile*, are chiefly four; whereof the three former moſt regard the ſingle Corpuſcles

as such; and the last, the manner of their Union in the aggregate or body they make up.

But before I enter upon particulars, give me leave to advertise you here once for all, That in the following Notes about *Volatility* and *Fixtness*, when I speak of the Corpuscles or minute parts of a body, I doe not mean strictly either the Elementary parts, such as Earth and Water, or the Hypostatical Principles, such as Salt, Sulphur, or Mercury; for these things come not here into consideration: But onely such Corpuscles, whether of a simple, compounded or decompounded Nature, as have the particles they consist of so firmly united, that they will not be totally disjoyned or dissipated by that degree of Fire or Heat, wherein the matter is said to be volatile or to be fixt. But these combined particles will in their aggregate either ascend, or continue unraised *per modum Unius* (as they speak) or as one intire Corpuscle. As in a Corpuscle of Sal Armoniac,

niac, whether it be a natural or factitious thing, or whether it be perfectly similar, or compounded of differing parts, I look upon the intire Corpuscle as a volatile portion of matter; and so I doe on a Corpuscle of Sulphur, though experience shews when 'tis kindled, that it has great store of acid Salt in it, but which is not extricated by bare sublimation: And so Colcothar of Vitriol falls under our consideration as a fixt body, without inquiring what cupreous or other mineral and not totally fixt parts may be united with the Earthly ones; since the fires, we expose it to, do not separate them.

And this being premised in the general, I now proceed to some particulars. And first to make a volatile body, the parts should be very small. For, *cæteris paribus*, those that are so, are more easily put into motion by the action of the fire and other Agents, and consequently more apt to be elevated, when, by the determination of the movent, the situation

of the neighbouring bodies, or other Mechanical Circumſtances, the agitated Corpuſcles can continue their motion with leſs reſiſtance upwards than any other way, (as either downwards or horizontally.) And if, as 'tis highly probable, that which in light bodies, or at leaſt in moſt of them, is wont to paſs for *poſitive* Levity, be but a leſs degree of gravity than that of thoſe contiguous bodies that raiſe them; it will happen, that in very many caſes, (for I ſay not in all) the great proportion of the ſurface of a Corpuſcle to its bulk, (which is uſually greater in the leſſer particles) by making it more apt to be wrought on, either by the air agitated by the fire, or by the *effluvia* of kindled fuell, or by the impulſe of the ſhaken Corpuſcles of the body it ſelf, will much facilitate the elevation of ſuch a minute particle, by expoſing a greater portion of it to the action of the agent, as it will oftentimes alſo facilitate the renewed ſuſtentation of ſuch a ſmall body in the air,

air, which reſiſts more the deſcent of particles whoſe ſurfaces are large, than of others of the ſame gravity and bulk: As a leaf of paper diſplayed will much longer hover in the Air, than if it were reduced into a ball or pellet. That this minuteneſs of particles may diſpoſe them to be carried upwards, by the impulſe of other bodies and that of the agitated Air, is very obvious to be obſerved: As we ſee, that Horſes in a high-way, though they be not able with the ſtrokes of their feet to make ſtones, or gravel, or clods of Earth fly up, yet they will eaſily raiſe clouds of duſt oftentimes mingled with the ſmaller grains of ſand. And where Timber is ſawing, the ſame wind that will not in the leaſt move the beams, and ſcarce at all move the chips, will eaſily carry up the Saw-duſt into the Air. And we ſee in our Chimneys, that the ſmoak readily aſcends, whilſt even ſmall clods of ſoot, which is but an aggregate of the particles of ſmoak, fall headlong down.

CHAP. II.

THE next qualification requiſite in the corpuſcles of Volatile bodies is, that they be not too ſolid or heavy. For if they be ſo, though their bulk be very ſmall, yet, unleſs other Circumſtances do much compenſate their weight, 'twill be very difficult to elevate them, becauſe of the great diſproportion of their ſpecific gravity *to* that of the Air, (which contributes to ſuſtain and even raiſe many ſorts of volatile parts) and *to* the ſtrength of the igneous effluvia or other agents that would carry them up. Thus we ſee, that filings of Lead or Iron, and even Minium (which is the calx of Lead) though the grains they conſiſt of be very ſmall, will not eaſily be blown up like common duſt, or meal, or other powders made of leſs ponderous materials.

A third Qualification to be deſired in the corpuſcles that ſhould make up

up a Volatile body is, that they be conveniently ſhaped for motion. For if they be of branched, hook'd, or other very irregular or inconvenient figures, they will be apt to be ſtopt and detained by other bodies, or entangled among themſelves, and conſequently very difficult to be carried upwards, in regard that, whilſt they are thus faſtened either to one another, or to any ſtable body, each ſingle Corpuſcle is not onely to be conſidered, as having its own peculiar bulk, ſince its coheſion with the other corpuſcle or body that detains it, makes them fit to be look'd upon *per modum Unius*; that degree of heat they are expoſed to being preſumed uncapable of disjoyning them. And this may be one Reaſon, why Water, though it be ſpecifically heavier than Oil, yet is much more eaſily brought to exhale in the form of vapours than is Oil, whoſe corpuſcles by the laſting ſtains they leave on cloath, wood, wool, &c. (which water will but tranſiently moiſten, not ſtain)

ſtain) ſeems to be of very intangling figures.

The fourth and laſt qualification requiſite in a Volatile body is, that the parts do looſely adhere, or at leaſt be united in ſuch a manner, as does not much indiſpoſe them to be ſeparated by the fire in the form of fumes or vapours.

For he that conſiders the matter, will eaſily grant, that, if the contexture of the corpuſcles, whereof a body conſiſts, be intricate, or their coheſion ſtrong, their mutual implication, or their adherence to each other, will make one part hinder another from flying ſeparately away, and their conjunction will make them too heavy or unweildy to be elevated together, as intire though compounded parts. Thus we ſee, that in Spring, or the beginning of Summer, a wind, though not faint, is unable to carry off the lighteſt leaves of trees, becauſe they ſtick faſt to the bows and twigs on which they grow, but in Autumn, when that adheſion ceaſes, and

and the leaves ſit but looſely on, a wind no ſtronger than that they reſiſted before, will with eaſe blow them off, and perhaps carry them up a good way into the Air. But here note, that it was not without ſome cauſe, that I added above, that in a fluid body, the parts ſhould at leaſt be united in ſuch a manner, as does not much indiſpoſe them to be ſeparated. For 'tis not impoſſible, that the parts of a body may, by the figures and ſmoothneſs of the ſurfaces, be ſufficiently apt to be put into motion, and yet be indiſpoſed to admit ſuch a motion as would totally ſeparate them and make them fly up into the Air. As, if you take two pieces of very flat and well-poliſhed marble or glaſs, and lay them one upon the other, you eaſily make them ſlide along each others ſurfaces, but not eaſily pull up one of them, whileſt the other continues its ſtation. And when Glaſs is in the ſtate of fuſion, the parts of it will eaſily ſlide along each other, (as is uſual in thoſe of other

ther fluids) and consequently change places, and yet the continuity of the whole is not intirely broken, but every corpuscle does somewhere touch some other corpuscle, and thereby maintain the cohesion that indispoſes it for that intire separation accompanied with a motion upwards that we call avolation. And so, when Salt-peter alone, is in a Crucible exposed to the fire, though a very moderate degree of it will suffice to bring the Salt to a state of fusion, and consequently to put the corpuscles that compose it into a restless motion; yet a greater degree of heat, than is necessary to melt it, will not extricate so much as the Spirits, and make them fly away.

CHAP. III.

THE foregoing Doctrine of the Volatility of bodies may be as well illustrated as applied, if we proceed to deduce from it the generall

rall ways of Volatilization of bodies, or of introducing volatility into an assigned portion of matter. For these wayes seem not inconveniently reducible to five, which I shall severally mention, though Nature and Art do usually imploy two or more of them in conjunction. For which Reason I would not, when I speak of one of these wayes, be understood as if, excluding the rest, I meant that no other concurred with it.

The first of the five ways or means of Volatilizing a body is, to reduce it into minute parts, and, *cæteris paribus*, the more minute they are the better.

That the bringing a body into very minute parts may much conduce to the volatilizing of it, may be gathered from the vulgar practice of the Chymists, who when they would sublime or distill Antimony, Sal Armoniac, Sea-salt, Nitre, *&c.* are wont to beat them to powders to facilitate their receiving a further comminution by the action of the fire.

And

And here I obſerve, that in ſome bodies this comminution ought not to be made onely at firſt, but to be continued afterwards. For Chymiſts find by experience, though perhaps without conſidering the reaſon of it, that Sea-ſalt and Nitre, will very hardly afford their Spirits in Diſtillations, without they be mingled with powdered clay or bole, or ſome ſuch other additament, which uſually twice or thrice exceeds the weight of the Salt it ſelf: Although theſe additaments, being themſelves fixt, ſeem unlikely to promote the volatilization of the bodies mixt with them, yet by hindering the ſmall grains of Salt to melt together into one lump or maſſe, and conſequently by keeping them in the ſtate of Comminution, they much conduce to the driving up of the Spirits or the finer parts of the Salts by the operation of the fire.

But to proſecute a little what I was ſaying of the Conduciveneſs of bringing a body into ſmall parts to the

the volatilization of it, I ſhall adds that in ſome caſes the Comminution may be much promoted by employing Phyſical, after Mechanical, ways; and that, when the parts are brought to ſuch a pitch of exiguity, they may be elevated much better than before. Thus, if you take filings of *Mars*, and mix them with *Sal Armoniack*, ſome few parts may be ſublimed; but if, as I have done, you diſſolve thoſe filings in good Spirit of Salt inſtead of Oil of Vitriol, and having coagulated the ſolution, you calcine the greeniſh Cryſtalls or *vitriolum Martis* that will be afforded, you may with eaſe, and in no long time, obtain a *Crocus Martis* of very fine parts; ſo that I remember, when we exquiſitely mingled this very fixt powder with a convenient proportion of *Sal Armoniac*, and gradually preſs'd it with a competent fire, we were able to elevate at the firſt Sublimation a conſiderable part of it; and adding a like, or ſomewhat inferiour, proportion of freſh *Sal Armoniac* to the *Caput Mortuum*,

tuum, we could raiſe ſo conſiderable a part of that alſo, and in it of the *Crocus*, that we thought, if we had had Conveniency to purſue the operation, we ſhould, by not many repeated Sublimations, have elevated the whole *Crocus*, which (to hint that upon the by,) afforded a Sublimat of ſo very aſtringent a Taſt, as may make the trial of it in ſtanching of blood, ſtopping of fluxes, and other caſes, where potent aſtriction is deſired, worthy of a Phyſicians Curioſity.

CHAP. IV.

THE ſecond means to volatilize bodies is, to rub, grind, or otherwiſe reduce their corpuſcles to be either ſmooth, or otherwiſe fitly ſhaped to clear themſelves, or be diſintangled from each other.

By reaſon of the minuteneſs of the corpuſcles, which keeps them from being ſeparately diſcernible by the Eye,

Eye, 'tis not to be expected, that immediate and ocular Instances should be given on this occasion; but that such a change is to be admitted in the small parts of many bodies, brought to be volatile, seems highly probable from the account formerly given of the requisites or conditions of Volatility, whose introduction into a portion of matter will scarce be explicated without the intervention of such a change. To this second Instrument of Volatilization, in concurrence with the first, may probably be referred the following Phænomena: In the two first of which there is imployed no additional volatile Ingredient; and in the fourth, a fixt body is disposed to volatility by the operation of a Liquour, though this be carefully abstracted from it.

1. If Urine freshly made be put to distill, the Phlegm will first ascend, and the Volatile salt will not rise 'till that be almost totally driven away, and then requires a not inconsiderable degree of fire to elevate it. But,

if you putrefie or digeſt Urine, though in a well-cloſed Glaſs-Veſſel, for ſeven or eight weeks, that gentle warmth will make the ſmall parts ſo rub againſt, or otherwiſe act upon, one another, that the finer ones of the Salt will perhaps be made more ſlender and light, and however will be made to extricate themſelves ſo far as to become volatile, and, aſcending in a very gentle heat, leave the greateſt part of the phlegm behind them.

2. So, if Muſt, or the ſweet juice of Grapes, be diſtilled before it have been fermented, 'tis obſerved by Chymiſts, and we have tried the like in artificial Wine made of Raiſins, that the phlegm, but no ardent Spirit, will aſcend. But when this Liquour is reduced to Wine by fermentation, which is accompanied with a great and inteſtine commotion of the juſtling parts, hitting and rubbing againſt one another, whereby ſome probably come to be broken, others to be variouſly ground and ſubtilized, the more

more ſubtile parts of the Liquour being extricated, or ſome of the parts being, by theſe operations, brought to be ſubtile, they are qualified to be raiſed by a very gentle heat before the phlegm, and convene into that fugitive Liquour, that Chymiſts, for its activity, call Spirit of Wine. Nor is it onely in the ſlighter Inſtances afforded by Animals and Vegetables, that Volatility may be effected by the means lately mentioned: For experience hath aſſured me, that 'tis poſſible, by an artificial and long digeſtion, wherein the parts have leiſure for frequent juſtlings and attritions, ſo to ſubtilize and diſpoſe the corpuſcles even of common Salt for Volatility, that we could make them aſcend in a moderate fire of Sand without the help of Bole, Oil of Vitriol, or any Volatilizing additament; and, which is more conſiderable, the Spirit would in riſing precede the Phlegm, and leave the greateſt part thereof behind it.

This inteſtine commotion of parts

capable of producing Volatility in the more disposed portions of a body, though it be much more easie to be found in Liquours, or in moist and soft bodies, yet I have sometimes, though rarely, met with it in dry ones. And particularly I remember, that some years ago having, for trial sake, taken Mustard-seed, which is a body pregnant with subtile parts, and caused it to be distilled *per se* in a Retort, I had, as I hoped, (without any more ado,) a great many grains of a clear and figured Volatile salt at the very first distillation: which Experiment having, for the greater security, made a second time with the like success, I mentioned it to some Lovers of Chymistry, as what I justly supposed they had not heard of. I leave it to farther Inquiry, whether, in a body so full of Spirits as Mustard-seed, the action and re-action of the parts among themselves, perhaps promoted by just degrees of fire, might not suffice to make in them a change equivalent in order to Volatilization,

and

and the yielding a Volatile Salt, to that which we have obſerved Fermentation and Putrefaction to have made in the juice of Grapes, Urine, and ſome other bodies. How far the like ſucceſs may be expected in other Trialls, I cannot tell; eſpecially not having by me any Notes of the events of ſome Attempts which that Inquiry put me upon: Onely I remember in general, that, as ſome trials, I made with other Seeds, and even with Aromatick ones, did not afford me any Volatile Salt; ſo the ſucceſs of other trials made me now and then think, that ſome ſubjects of the Vegetable kingdom, whence we are wont to drive over acid Spirits, but no dry Salt, may be diſtilled with ſo luckily regulated a heat, as to afford ſomething, though but little, of Volatile Salt; and that perhaps more bodies would be found to doe ſo, were they not too haſtily or violently preſt by the fire, whereby ſuch ſaline ſchematiſms of the deſired parts of the matter are (by being diſſipated or

confounded) deſtroyed or vitiated; as in a ſlow, dextrous, or fortunate way of management would come forth, not in a liquid, but a ſaline form. Of which Obſervation we may elſewhere mention ſome Inſtances, and ſhall before the cloſe of this Paper name one, afforded us by crude Tartar.

3. Though Silver be one of the fixedſt bodies that we know of, yet that 'tis not impoſſible but that, chiefly by a change of Texture, it may ſtrangely be diſpoſed to Volatility, I was induced to think by what I remember once happened to me. A Gentleman of my acquaintance, ſtudious of Chymical *Arcana*, having lighted on a ſtrange Menſtruum, which he affirmed, and I had ſome cauſe to believe, not to be corroſive, he abſtracted it from ſeveral metalls, (for the ſame Liquour would ſerve again and again,) and brought me the *Remainders*, with a deſire that I would endeavour to reduce thoſe of Lead and Silver into the priſtine metals

tals again, which he had in vain attempted to doe: whereupon, though I found the white Calx of Lead reducible, yet when I came to the Calx of Silver, I was not able to bring it into a body; and having at length melted some Lead in a gentle fire, to try whether I could make it swallow up the *Calx*, in order to a farther operation, I was not a little surprized to find, that this mild heat made the *Calx* of Silver presently fly away and sublime in the form of a *farina volatilis*, which whitened the neighbouring part of the Chimney, as well as the upper part of the Crucible.

4. From that which Chymists themselves tell us, I think we may draw a good Argument *ad hominem*, to prove, that Volatility depends much upon the texture and other Mechanical affections of a body. For divers of those Hermetick Philosophers (as they are called) that write of the *Elixir*, tell us, that when their Philosophick Mercury or grand Solvent, being sealed up together with a

third or fourth part of Gold in a glaſs-Egg, is kept in convenient degrees of fire, the whole matter, and conſequently the Gold, will, by the mutual operation of the included Subſtances, be ſo changed, that not onely 'twill circulate up and down in the glaſs, but, in caſe the digeſtion or decoction ſhould be broken off at a certain inconvenient time, the Gold would be quite ſpoil'd, being, by the paſt and untimely-ended operation, made too Volatile to be reducible again into Gold: whereas, if the decoction be duly continued unto the end, not onely the Gold, but all the Philoſophical Mercury or *Menſtruum* will be turned into a Sulphur or powder of a wonderfully fixt nature. I know, there are ſeveral Chryſopæans, that ſpeak much otherwiſe of this Operation, and tell us, that the Gold imployed about it muſt be Philoſophick Gold: But I know too, that there are divers others (and thoſe too none of the leaſt candid or rational) that ſpeak of it as I have done; and That

is

is ſufficient to ground an Argument on towards all thoſe that embrace Their doctrine. And in this caſe 'tis conſiderable, that 'tis not by any ſuperadded additament, that the moſt fixt body of Gold is made volatile, but the ſame maſſy matter, conſiſting of Gold and Philoſophick Mercury, is, by the change of texture produced or occaſioned by the various degrees and operations of fire upon it, brought to be firſt Volatile, and then extreamly fixt. And having ſaid this in reference to one tribe of the Modern Spagyriſts; to another of them, the *Helmontians*, I think I can offer a good Argument *ad hominem* from the Teſtimony and Experiments of the Founder of their Sect.

5. The acute *Helmont*, among other prodigious powers that he aſcribes to the Alkaheſt, affirms, that, by abſtracting it frequently enough, it would ſo change all tangible bodies, and conſequently ſtones and metals, that they might be diſtilled over into Liquours equiponderant

to

to the reſpective bodies that afforded them, and having all the Qualities of Rain-water; which if they have, I need not tell you that they muſt be very Volatile. And I ſee not how thoſe that admit the Truth of this ſtrange Alkaheſtical operation, can well deny, that Volatility depends upon the Mechanical affections of matter, ſince it appears not, that the Alkaheſt does, at leaſt in our caſe, work upon bodies otherwiſe than Mechanically. And it muſt be confeſt, that the ſame material parts of a portion of corporeal ſubſtance, which, when they were aſſociated and contexed (whether by an *Archeus*, ſeed, form, or what elſe you pleaſe,) after ſuch a determinate manner, conſtituted a ſolid and fixt body, as a Flint or a lump of Gold; by having their Texture diſſolved, and (perhaps after being ſubtilized) by being freed from their former implications or firm coheſions, may become the parts of a fluid body totally Volatile.

CHAP.

CHAP. V.

THE fourth means of making a body Volatile is, by associating the particles to be raised with such as are more Volatile than themselves, and of a figure fit to be fastened to them, or are at least apt, by being added to them, to make up with them corpuscles more disposed than they to Volatility. This being the grand Instrument of Volatilization, I shall spend somewhat the more time about it: But I shall first here a little explain the last clause, (that I may not be obliged to resume it elsewhere,) by intimating, that 'tis not impossible, that the particles of an additament, though not more volatile than those of the body 'tis mixt with, and perhaps though not volatile at all, will yet conduce to volatilize the body wherewith 'tis mingled. For the particles of the additament may be of such figures, and so associated with those of the body to be elevated,

as

as in this to enlarge the former pores, or produce new ones, by intercepting little cavities (for they muſt not be great ones) between the particles of a body to be raiſed, and thoſe of the additament. For, by theſe and other ſuch ways of aſſociation, the corpuſcles, reſulting from the combination or coalition of two or more of theſe differing particles, may, without becoming too big and unwieldy, become more conveniently ſhaped, or more light in proportion to their bulk, and ſo more eaſily buoyed up and ſuſtained in the air, (as when the Lid of a Copper-box being put on, makes the whole box emerge and ſwim in water, becauſe of the intercepted cavity, though neither of the parts of the box would doe ſo,) or otherwiſe more fitted for avolation than the particles themſelves were before their being joined to thoſe of the additament.

By two things chiefly the corpuſcles of the additament may contribute to the elevation of a body. For *firſt*,

first, the parts of the former may be much more disposed for avolation than is necessary to their own Volatility. As when in the making of Sal Armoniac, the saline particles of Urine and of Soot are more fugitive than they need be to be themselves sublimed, and thereby are advantaged to carry up with them the more sluggish corpuscles whereof Sea-salt consists. And *next*, they may be of figures so proper to fasten them well to the body to be elevated, that the more fugitive will not be driven away or disjoyned from the more fixt by such a degree of Heat as is sufficient to raise them both together: To which effect the congruity or figuration is as well required, as the lightness or volatility of the particles of the additament. And therefore some of the fugitivest bodies that we know, as Spirit of Wine, Camphire, *&c.* will not volatilize many bodies which will be elevated by far less fugitive additaments; because the corpuscles of Spirit of Wine stick

not

not to those of the body they are mingled with, but, easily flying up themselves, leave those behind them, which they did rather barely touch than firmly adhere to: Whereas far less fugacious Liquours, if they be indowed with figures that fit them for a competently firm cohesion with the body they are mingled with, will be able to volatilize it. Of which I shall now give you some Instances in bodies that are very ponderous, or very fixt, or both.

And I shall begin with Colcothar, though it being a vitriolate *calx*, made by a lasting and vehement fire, 'tis (consequently) capable of resisting such a one. This being exquisitely ground with an equal weight of Sal Armoniac, which is it self a Salt but moderately volatile, will be in good part sublimed into those yellow Flowers, which we have elsewhere more particularly taught to prepare, under the name of *Ens primum Veneris*; in which, that many vitriolate corpuscles of the Colcothar are really ele-

elevated, you may eaſily find by putting a grain or two of that reddiſh Subſtance into a ſtrong infuſion of Galls, which will thereby immediately acquire an inky colour.

Steel alſo, which, to deſerve that name, muſt have endured extraordinary violences of the fire, and greater than is needfull to obtain other metalls from their Mother Earth; Steel it ſelf, I ſay, being reduced to filings, and diligently ground with about an equal weight of Sal Armoniac, will, if degrees of fire be skilfully adminiſtred, (for 'tis eaſie to err in that point,) without any previous calcination or reduction to a *Crocus*, ſuffer ſo much of the metall to be carried up, as will give the Sal Armoniac a notable colour, and an ironiſh taſt.

And here it will be proper to obſerve, for the ſake of practical Chymiſts, that the Quantity or Proportion of the Volatile additament is to be regarded; though not ſo much as its Nature, yet more than it is wont

to

to be: And divers bodies, that are thought either altogether unfit for Sublimation, or at leaſt uncapable to have any conſiderable portion of them elevated, may be copiouſly enough ſublimed, if a greater proportion of the additament, than we uſually content our ſelves with, be skilfully imployed. And in the newly-mentioned Inſtance of Filings of Steel, if, in ſtead of an equal weight of *Sal Armoniac*, the treble weight be taken, and the operation be duly managed, a far greater quantity of the metall may be raiſed, eſpecially if freſh *Sal Armoniac* be carefully ground with the *Caput Mortuum*. And Sal Armoniac may perhaps be compounded with ſuch other bodies, heavier than it ſelf, as may qualifie it, when it is thus clogged, to elevate ſome congruous bodies better than it would of it ſelf alone. And I ſhall venture to add this farther Advertiſement, That if, beſides the plenty of the additament, there be a ſufficient fitneſs of its particles to lay hold

hold on those of the body to be wrought on, Mineral bodies, and those ponderous enough, may be employed to volatilize other heavy bodies. And I am apt to think, that almost, if not more than almost, all Metalls themselves may by copious additaments and frequent Cohobations be brought to pass through the neck of the Retort in distillation; and perhaps, if you melt them not with equal parts, but with many parts of *Regulus* of *Antimony*, and then proceed as the hints now given will direct you, you will not find cause to despise what I have been saying.

You know what endeavours have been, and are still fruitlesly, imployed by Chymists to elevate so fixt a body as *Salt of Tartar* by additaments. I shall not now speak much of the enterprize in generall, designing chiefly to tell you on this occasion, that, whereas frequent experience shews, that *Sal Armoniac* being abstracted from *Salt of Tartar*, not onely the

Salt of Tartar is left at the bottom, but a good part of the Sal Armoniac is left behind with it; I ſuſpected the cauſe might be, that Sal Armoniac, by the operation of the Alkaly of Tartar, is reduced into Sea-ſalt, and Urinous or fuliginous Salt, as 'twas at firſt compoſed of thoſe differing Ingredients; and that by this means the volatil Salt being looſened or disintangled from the reſt, and being of a very fugacious Nature, flyes eaſily away it ſelf, without ſtaying long enough to take up any other Salt with it. And therefore, if this *Analyſis* of the Sal Armoniac could be prevented, it ſeemed not impoſſible to me, that ſome part of the Salt of Tartar, as well as of Colcothar and Steel, might be carried up by it: And accordingly having cauſed the Ingredients to be exceedingly well dryed, and both nimbly and carefully mixt, and ſpeedily expoſed to the fire, I have ſometimes had a portion of Salt of Tartar carried up with the Sal Armoniac: but this happened

pened so very rarely, that I suspected some peculiar fitness for this work in some parcels of Sal Armoniac, that are scarce but by the effect to be discerned from others. But however, what has happened to us may argue the Possibility of the thing, and may serve to shew the volatilizing efficacy of Sal Armoniac; which is a Compound, that I elsewhere recommend, and doe it now again, as one of the usefullest Productions of vulgar Chymistry.

And since I have mentioned the Volatilization of *Salt of Tartar*, presuming your Curiosity will make you desire my Opinion about the Possibility of it, I shall propose to you a distinction, that perhaps you doe not expect, by saying, that I think there is a great deal of difference between the making a Volatile Salt of Tartar, and the making Salt of Tartar Volatile. For, though this seem to be but a Nicety, yet really it is none; and it is very possible, that a man may from Tartar obtain a Volatile salt,

and yet be no wise able to volatilize that Tartareous Salt, that has been once by the incineration of the Tartar brought to fixt Alkaly. I have in the *Sceptical Chymist* summarily delivered a way, by which both I, and some Spagyrists that learned it of me, obtained from a mixture of Antimony, Nitre, and crude Tartar, a Volatil salt, which in probability comes from the last named of those three bodies; but experience carefully made has assured me, that without any additament, by a distillation warily and very slowly made, (insomuch that I have spent near a week in distilling one pound of matter) very clean Tartar, or at least the Crystalls of Tartar, may, in conveniently shaped Vessels, be brought to afford a Substance that in Rectification will ascend to the upper part of the Vessel, in the form of a Volatil Salt, as if it were of Urine or of Harts-horne; of which (Tartareous) Salt, I keep some by me: But this operation requires not onely a dexterous,

terous, but a patient distiller.

But now as to the making a fixt Alkaly of Tartar become Volatil, I take it to be another, and have found it to be a far more difficult, work; the common Processes of performing it being wont to promise much more than they can make good; which I may justly say of some other, that private men have vaunted for great *Arcana*, but upon triall have satisfied me so little, that I have divers times offered pretenders to make Salt of Tartar Volatil, that without at all inquiring into their Processes, I would lay good wagers, that they could not doe what they pretended; not onely as divers Philosophical Spagyrists require, without any visible additament, but by any additament whatever; provided I were allowed to bring the Salt of Tartar my self, and to examine the Success, not by what may appear in the Alembic and Receiver, but by the weight of what would remain in the bottom. For I have convinced some of the more Ingenuous Ar-

tists, that the Salt that sublimed was not indeed the Alkaly of Tartar, but somewhat that was by the operation produced, or rather extricated out of the additaments. But yet I would not be thought to affirm, that 'tis not possible to elevate the fixt Salt of Tartar. For sometimes I have been able to doe it, even at the first Distillation, by an artificial additament perhaps more fixt than it self; but, though the operation was very gratefull to me, as it shewed the Possibility of the thing, yet the paucity of the Salt sublimed and other Circumstances, kept me from much valuing it upon any other account. And there are other wayes, whereby Experience has assured me, that Salt of Tartar may be raised. And if one of them were not so uncertain, that I can never promise before hand that it will at all succeed, and the other so laborious, difficult and costly, that few would attempt or be able to practice it, I should think them very valuable things; since by the former,

mer way moſt part of the Salt of Tartar was quickly brought over in the form of a Liquor, whoſe piercing ſmell was ſcarce tolerable; and by the latter way ſome Salt of Tartar of my own, being put into a Retort, and urged but with ſuch a fire as could be given in a portable Sand-furnace, there remained not at the bottom near one half of the firſt weight, the additament having carried up the reſt, partly in the form of a Liquor, but chiefly in that of a white Sublimate, which was neither ill-ſented, nor in taſt corroſive, or alcalizat, but very mild, and ſomewhat ſweetiſh. And I doe not much doubt, but that by other wayes the fixt Alkaly of Tartar may be elevated, eſpecially if, before it be expoſed to the laſt operation of the fire, it be dextrouſly freed from the moſt of thoſe Earthy and Viſcous parts, that I think may be juſtly ſuſpected to clog and bind the truly ſaline ones.

But I have too long digreſt, and therefore ſhall intimate onely upon

the by, that even the ſpurious *Sal Tartari* volatilized that is made with Spirit of Vinegar, may, if it be well prepared, make amends for its Empyreumatical ſmell and taſt, and may, notwithſtanding them, in divers caſes be of no deſpicable uſe, both as a Medicine, and a Menſtruum.

CHAP. VI.

BEfore I draw towards a Concluſion of theſe Notes about Volatility, perhaps it will not be amiſs, to take notice of a Phænomenon, which may much ſurpriſe, and ſometimes diſappoint thoſe that deal in Sublimations, unleſs they be forewarned of it. For though it be taken for granted, and for the moſt part may juſtly be ſo, that by carefully mingling what is ſublimed with what remains, and re-ſubliming the mixture, a greater quantity of the body to be ſublimed may be elevated the ſecond time than was the firſt, and

and the third time than the ſecond, and ſo onwards; yet I have not found this Rule alwayes to hold, but in ſome Bodies, as particularly in ſome kinds of dulcified Colcothar, the Sal Armoniac, would at the firſt Sublimation carry up more of the fixed powder, than at the ſecond or third. So that I was by ſeveral Tryalls perſwaded, when I found a very well and highly coloured powder elevated, to lay it by for uſe, and thereby ſave my ſelf the labour of a proſecution, that would not onely have proved uſeleſs, but prejudicial. And if I miſremember not, by often repeated Cohobations, (if I may ſo call them) of Sal Armoniac upon crude or Mineral Antimony, though the Sublimate that was obtained by the firſt Operation, was much of it variouſly, and in ſome places richly, coloured; yet afterwards, the Salt aſcended from time to time paler and paler, leaving the Antimony behind it. Which way of making ſome Minerals more fixt and fuſible I conceive

ceive may be of great uſe in ſome Medicinal Preparations, though I think it not fit to particularize them in this place: Where my chief intent was, to mention the Phænomenon it ſelf, and invite you to conſider, whether it may be aſcribed to this, that by the reiterated action of the fire, and grinding together of the body to be raiſed, either the corpuſcles of the Sal Armoniac, or thoſe of the other body, may have thoſe little hooked or equivalent particles, whereby they take hold of one another, broken or worn off; and whether the indiſpoſedneſs of the Colcotharine or Antimonial parts to aſcend, may not in ſome caſes be promoted by their having, by frequent attritions, ſo ſmoothed their Surfaces that divers of them may cloſely adhere, like pieces of poliſhed Glaſs, and ſo make up Cluſters too unweildy to be ſo raiſed, as the ſingle corpuſcles they conſiſt of, were. Which change may diſpoſe them to be at once leſs Volatil and more Fuſible. Which Con-

Conjectures I mention to excite you to frame better, or at leaſt to make amends for my omiſſion of examining theſe, by trying whether the Sal Armoniac grown white again will be as fit as it was at firſt to carry up freſh bodies; and alſo by obſerving the weight of the unelevated part, and employing thoſe other wayes of *examen*, which I ſhould have done, if I had not then made Sublimations for another end, than to clear up the Doctrine of Volatility.

And here it may be profitable to ſome Chymiſts, though not neceſſary to my Subject, to intimate, that Sublimations may be uſeful to make very fine Comminutions of divers bodies. That thoſe that are elevated are reduced to a great fineneſs of parts, is obvious to be obſerved in many Examples, whence it has been anciently, not abſurdly, ſaid, that Sublimations are the Chymiſts Peſtles, ſince (as in Flowers of Sulphur and Antimony) they do really reſolve the eleva-

elevated bodies into exceeding fine Flower, and much finer than Peſtles and Mortars are wont to bring them to. But that which I intend in this Paragraph is not a thing ſo obvious, ſince 'tis to obſerve, that ſometimes even bodies ſo fixt as not at all to aſcend in Sublimation, may yet be reduced by that operation into powders extreamly fine. For exemplifying of which, I ſhall put you in mind, that though Spagyriſts complain much of the Difficulty of making a good Calx of Gold, and of the Imperfection of the few ordinary proceſſes preſcribed to make it, (which would be more complained of, but that Chymical Phyſicians ſeldom attempt to prepare it,) yet we are informed by triall, that by exactly grinding a thick amalgam of Gold and Mercury with a competent weight, (at leaſt equal to its own) of finely powdered Sulphur, we may, by putting the mixture to ſublime in a conveniently ſhaped Glaſs, by degrees of fire obtain a Cinaber that will leave behind it a finer Calx

of

of Gold than will be had by ſome far more difficult proceſſes.

But 'tis now time to draw towards a Concluſion of our Notes about Volatility; which Quality depends ſo much upon the contexture of the corpuſcles that are to be raiſed together, that even very ponderous bodies may ſerve for volatilizing additaments, if they be diſpoſed to faſten themſelves ſufficiently to the bodies they are to carry up along with them. For, though *Lead* be, ſave one, the heavieſt ſolid we know of, and though Quick-ſilver be the heavieſt body in the world, except Gold; yet trialls have aſſured us, that *Quick-ſilver* it ſelf being united by Amalgamation with a ſmall proportion of Lead, will by a fire that is none of the violenteſt, and in cloſe Veſſels, be made to carry over with it ſome of the Lead. As we clearly found by the increaſed weight of the Quick-ſilver that paſſed into the Receiver; which, by the way, may make us cautious how we conclude Quick-

ſilver

ſilver to be pure, meerly from its having been diſtilled over.

There remains but one body more heavy than thoſe I come from naming, and that is *Gold*; which, being alſo of a fixity ſo great that 'tis indeed admirable, I doe not wonder that not onely the more wary Naturaliſts, but the more ſevere among the Chymiſts themſelves ſhould think it incapable of being volatilized. But yet, if we conſider, how very minute parts Gold may be rationally ſuppoſed to conſiſt of, and to be diviſible into, me thinks it ſhould not ſeem impoſſible, that, if men could light on Volatil Salts endowed with figures fit to ſtick faſt to the corpuſcles of the Gold, they would carry up with them bodies, whoſe ſolidity can ſcarce be more extraordinary than their minuteneſs is: And in effect, we have made more than one *Menſtruum*, with which ſome particles of Gold may be carried up. But when I employed that which I recommended to you formerly under the name

name of *Menſtruum peracutum* (which conſiſts mainly, and ſometimes onely, of Spirit of Nitre, ſeveral times drawn from Butter of Antimony,) I was able, without a very violent fire, in a few hours to elevate ſo much crude Gold, as, in the neck of the Retort, afforded me a conſiderable Quantity of Sublimate, which I have had red as blood, and whoſe conſiſting partly of Gold manifeſtly appeared by this, that I was able with eaſe to reduce that metall out of it.

In reckoning up the Inſtruments of Volatilization, we muſt not quite leave out the mention of the *Air*, which I have often obſerved to facilitate the elevation of ſome bodies even in cloſe Veſſels; wherein, though to fill them too full be judged by many a Compendious practiſe, becauſe the ſteams have a leſs way to aſcend, yet Experience has ſeveral times informed me, that, at leaſt in ſome caſes, they take wrong meaſures, and that (to paſs by another Cauſe of their diſappointment) a large proportion

tion of Air, purposely left in the Vessels, may more than compensate the greater space that is to be ascended by the vapours or exhalations of the matter that is to be distilled or sublimed. And if, in close Vessels, the presence of the Air may promote the ascension of bodies, it may well be expected, that the elevation of divers of them may be furthered by being attempted in open Vessels, to which the Air has free access. And if we may give any credit to the probable Relations of some Chymists, the Air does much contribute to the volatilization of some bodies that are barely, though indeed for no short time, exposed to it. But the account on which the Air by its bare presence or peculiar operations conduces to the Volatilization of some bodies, is a thing very difficult to be determined, without having recourse to some Notions about Gravity and Levity, and of the Constitution of the corpuscles that compose the Air; which I take to be both very numerous and no

no less various. And therefore I must not in these occasional Notes lanch out into such a Subject, though, for fear I should be blamed for too much slighting my old acquaintance the *Air*, I durst not quite omit the power it has to dispose some bodies to Volatility.

A moderate attention may suffice to make it be discerned, that in what hath been hitherto delivered, I have for the most part considered the small portions of matter, to be elevated in Volatilization, as intire Corpuscles: And therefore it may be now pertinent, to intimate in a Line or two, that there may be also Cases, wherein a kind of Volatilization, improperly so called, may be effected, by making use of such additaments as break off or otherwise divide the particles of the corpuscles to be elevated, and by adhering to, and so clogging, one of the particles to which it proves more congruous, inable the other, which is now brought to be more light or disingaged, to ascend. This

may be illuſtrated by what happens, when Sal Armoniac is well ground with *Lapis Calaminaris* or with ſome fix'd Alkali, and then committed to diſtillation: For the Sea-ſalt, that enters the Compoſition of the Sal Armoniac, being detained by the ſtone or the Alkali, there is a divorce made between the common Salt and the urinous and ſuliginous Salts, that were incorporated with it, and being now diſingaged from it, are eaſily elevated. I elſewhere mention, that I have obſerved in Man's Urine a kind of native Sal Armoniac, much leſs Volatile than the fugitive that is ſublim'd from Man's Blood, Hartſhorn, *&c.* and therefore ſuppoſing, that a ſeparation of parts may be made by an Alkali, as well in this Salt as in the common factitious Sal Armoniac, I put to freſh Urine a convenient proportion (which was a plentifull one) of Salt of Pot-aſhes (that being then at hand) and diſtilling the Liquor, it yielded, according to expectation, a Spirit more Volatile

latile than the Phlegm, and of a very piercing taſt; which way of obtaining a Spirit without any violence of fire, and without either previouſly abſtracting the Phlegm, (as we are fain to do in freſh Urine) or tediouſly waiting for the fermentation of ſtale Urine, I taught ſome Chymiſts, becauſe of the uſefulneſs of Spirit of Urine; which being obtained this innocent way, would probably be employed with much leſs ſuſpicion of corroſiveneſs, than if in the operation I had made uſe of Quick-lime. Another Illuſtration of what I was not long ſince ſaying, may be fetch'd from the Experiment of making Spirit of Nitre by mixing Salt-peter with Oil of Vitriol, and diſtilling them together: For the Oil does ſo divide or break the corpuſcles of the Nitre, that the now-diſpoſed particles of that Salt, which amount to a great portion of the whole, will be made eaſily enough to aſcend even with a moderate fire of Sand, and ſometimes without any

fire at all, in the form of Spirits, exceeding unquiet, ſubtle, and apt to moak away.

To which Inſtances of this imperfect kind of Volatilization more might be added, but that you may well think, I have detain'd you but too long already with indigeſted Notes about *one* Quality.

CHAP. VII.

THe laſt means of Volatilizing bodies is, the operation of the Fire or ſome other actual Heat: But of this, which is obvious, it would be ſuperfluous to diſcourſe. Onely this I ſhall intimate, that there may be bodies, which, in ſuch degrees of fire as are wont to be given in the vulgar operations of Chymiſts, will not be elevated, which yet may be forced up by ſuch violent and laſting fires, as are employed by the Melters of Ores, and Founders of Guns, and ſometimes by Glaſs-makers. And on this

this Conſideration I ſhall here obſerve to you, ſince I did not doe it at my entrance on theſe Notes, that Chymiſts are wont to ſpeak, and I have accordingly been led to treat, of Volatility and Fixity in a popular ſenſe of thoſe Terms. For if we would conſider the matter more ſtrictly, I preſume we ſhould find that Volatility and Fixity are but relative Qualities, which are to be eſtimated, eſpecially the former of them, by the degree of fire to which the body, whereto we aſcribe one or other of thoſe Qualities, is expoſed; and therefore it is much more difficult than men are aware of, to determine accurately, when a body ought to be accounted Volatile and when not; ſince there is no determinate degree of Heat agreed on, nor indeed eaſie to be deviſed, that may be as a ſtandard, whereby to meaſure Volatility and Fixtneſs: And 'tis obvious, that a body, that remains fixt in one degree of fire, may be forced up by another. To which may be added,

agree-

agreeably to what I lately began to obſerve, that a body may paſs for abſolutely fixt among the generality of Chymiſts, and yet be unable to perſevere in the fires of Founders and Glaſs-makers: Which brings into my mind, that not having obſerved, that Chymiſts have examined the Fixity of other bodies than metalline ones by the Cupel, I had the Curioſity to put dry Salt of Tartar upon it, and found, as I expected, that in no long time it manifeſtly waſted in ſo vehement a heat, wherein alſo the Air came freely at it, (though Quick-lime, handled after the ſame way, loſt not of its weight,) and having well mixed one ounce of good Salt of Tartar with treble its weight of Tobacco-pipe Clay, we kept them but for two, or at moſt three hours, in a ſtrong fire; yet the Crucible being purpoſely left uncovered, we found the Salt of Tartar ſo waſted, that the remaining mixture (which was not flux'd) afforded us not near a quarter of an ounce of Salt. And indeed I

ſcarce

ſcarce doubt, but that in ſtrictneſs divers of thoſe bodies that paſs for abſolutely fixt, are but ſemi-fixt, or at leaſt but comparatively and relatively fix'd, that is, in reference to ſuch degrees of fire, as they are wont to be expoſed to in the Diſtillations, Sublimations, *&c.* of Chymiſts; not ſuch as are given in the raging fires of Founders, and Glaſs-makers. And perhaps even the fires of Glaſs-makers and Say-maſters themſelves are not the moſt intenſe that may poſſibly be made in a ſhort time, provided there be but ſmall portions of matter to be wrought on by them. And in effect, I know very few bodies, beſides Gold, that will perſevere totally fixt in the vehementeſt degrees of fire that Trials have made me acquainted with. And I elſewhere tell you, that, though Tin, in our Chymical Reverberatories themſelves, is wont to be reduced but into a *Calx* that is reputed very fixt; yet in thoſe intenſe fires, that a *Virtuoſo* of my acquaintance uſes in his Tin-Mines, there is not

not seldom found quantities of Tin carried up to a notable height in the form of a whitish powder, which, being in good masses forced off from the places to which it had fastened it self, does by a skillful reduction yield many a pound weight of good malleable metal, which seemed to me to be rather more, than less, fine than ordinary Tin.

Postscript,

Relating to Page 15. of this Tract; and here annext for their sakes, who have a mind to repeat the Experiment there delivered, that so they may know the quantities employed in it.

WIth two parts of this *Crocus* we ground very well three parts of Sal Armoniac, and having sublimed them in a strong fire, we took off the high coloured Sublimat, and put in either an equal weight, or a weight exceeding it by half, to the Caput Mortuum, we found after the second Sublimation, which was also high coloured, that of an ounce of Crocus we had raised six drams, that is, three quarters of the whole weight.

FINIS.

EXPERIMENTAL

NOTES

OF

The Mechanical Origine

OR

PRODUCTION

OF

FIXTNESS.

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NOTES

OF The Mechanical Origine OR *PRODUCTION* OF FIXTNESS.

CHAP. I.

FIXITY being the oppoſite Quality to Volatility, what we have diſcourſed about the latter, will make the nature of the former more eaſily underſtood, and upon that account allow me to make ſomewhat the quicker diſpatch of what I have to ſay of it.

The Qualifications that conduce most to the *Fixity* of a portion of matter, seem to be these.

First, the *grossness* or the bulk of the corpuscles it consists of. For if these be too big, they will be too unwieldy and unapt to be carried up into the Air by the action of such minute particles as those of the Fire, and will also be unfit to be buoyed up by the weight of the Air; as we see, that Vapours, whilst they are such, are small enough to swim in the Air, but can no longer be sustained by it, when they convene into drops of rain or flakes of snow. But here it is to be observed, that when I speak of the corpuscles that a fixt body consists of, I mean not either its Elementary or its Hypostatical Principles, as such, but onely those very little masses or clusters of particles, of what kind soever they be, that stick so firmly to one another, as not to be divisible and dissipable by that degree of fire in which the body is said to be fixt; so that each of those little Concretions,

ons, though it may it ſelf be made up of two, three, or more particles of a ſimpler nature, is conſidered here *per modum Unius*, or as one intire corpuſcle. And this is one Qualification conducive to the Fixtneſs of a body.

The *next* is the *ponderouſneſs* or ſolidity of the corpuſcles it is made up of. For if theſe be very ſolid, and (which ſolid and compact bodies uſually are) of a conſiderable *ſpecifick* gravity, they will be too heavy to be carried up by the *effluvia* or the action of the fire, and their ponderouſneſs will make them as unwieldy, and indiſpoſed to be elevated by ſuch Agents, as the groſſneſs of their bulk would make bigger corpuſcles, but of a proportionably inferiour ſpecifick weight. On which account the *calces* of ſome metals and minerals, as Gold, Silver, &c. though, by the operation of Solvents, or of the fire, or of both, reduced to powders exceedingly ſubtile, will reſiſt ſuch vehement fires, as will eaſily drive

up bigger, but less heavy and compact, corpuscles, than those *calces* consist of.

The *third* Qualification that conduces to the Fixity of a body, belongs to its *Integral parts*, not barely as they are several parts of it, but as they are aggregated or contexed into one body. For, the Qualification, I mean, is the ineptitude of the component corpuscles for avolation, by reason of their branchedness, irregular figures, crookedness, or other inconvenient shape, which intangles the particles among one another, and makes them difficult to be extricated; by which means, if one of them do ascend, others, wherewith 'tis complicated, must ascend with it; and, whatever be the account on which divers particles stick firmly together, the aggregate will be too heavy or unwieldy to be raised. Which I therefore take notice of, because that, though usually 'tis on the roughness and irregularity of corpuscles, that their cohesion depends; yet it some-

ſometimes happens, that the ſmoothneſs and flatneſs of their ſurfaces makes them ſo ſtick together, as to reſiſt a total divulſion; as may be illuſtrated by what I have ſaid of the coheſion of poliſhed marbles and the plates of glaſs, and by the fixity of glaſs it ſelf in the fire.

From this account of the Cauſes or Requiſites of Fixity, may be deduced the following means of giving or adding Fixation to a body, that was before either Volatile, or leſs fixt. Theſe means may be reduced to two general Heads; *Firſt*, the action of the Fire, as the parts of the body, expoſed to it, are thereby made to operate variouſly on one another. And *next*, the aſſociation of the particles of a volatile body with thoſe of ſome proper additament: Which term, [*of proper*] I rather imploy than that, one would expect, [*of fixt*;] becauſe 'twill ere long appear, that, in certain caſes, ſome volatile bodies may more conduce to the fixation of other volatile bodies, than ſome fixt

ones doe. But these two Instruments of Fixation being but general, I shall propose four or five more particular ones.

CHAP. II.

AND *first*, in some cases it may conduce to Fixation, that, either by an additament, or by the operation of the fire, the parts of a body be brought to touch each other in large portions of their surfaces. For, that from such a contact there will follow such a mutual cohesion, as will at least indispose the touching corpuscles to suffer a total divulsion, may appear probable from what we lately noted of the cohesion of pieces of marble and glass, and from some other *Phænomena* belonging to the History of *Firmness*, from which we may properly enough borrow some instances, at least for illustration, in the Doctrine of *Fixtness*, in regard that usually, though not always, the

the ſame things that make a body *Firm*, give it ſome degree of *Fixity*, by keeping it from being diſſipated by the wonted degrees of Heat, and Agitation it meets with in the Air. But to return to the contact we were ſpeaking of, I think it not impoſſible, (though you may perhaps think it ſtrange,) that the bare operation of the Fire may, in ſome caſes, procure a *Coheſion* among the particles, (and conſequently make them more Fixt,) as well as in others disjoyn them, and thereby make them more *Volatile*. For, as in ſome bodies, the figures and ſizes of the corpuſcles may be ſuch, that the action of the fire may rub or tear off the little beards or hooks, or other particles that intangle them, and by that means make it more eaſie for the corpuſcles to be disingaged and fly upwards; ſo in other bodies, the ſize and ſhape of the corpuſcles may be ſuch, that the agitation, cauſed by the fire, may rub them one againſt the other, ſo as by mutual attrition to grind, as 'twere, their

ſur-

ſurfaces, and make them ſo broad and ſmooth, if not alſo ſo flat, as that the contact of the corpuſcles ſhall come to be made according to a large portion of their ſuperficies, from whence will naturally follow a firm Coheſion. Which I ſhall illuſtrate by what we may obſerve among thoſe that grind glaſſes for Teleſcopes and Microſcopes. For, theſe Artificers, by long rubbing a piece of glaſs againſt a metalline Diſh or concave Veſſel, do by this attrition at length bring the two bodies to touch one another in ſo many parts of their congruous ſurfaces, that they will ſtick firmly to one another, ſo as ſometimes to oblige the Work-man to uſe violence to disjoyn them. And this inſtance (which is not the ſole I could alleage) may ſuffice to ſhew, how a Coheſion of corpuſcles may be produced by the mutual adaptation of their congruous ſurfaces. And if two groſſer corpuſcles, or a greater number of ſmaller, be thus brought to ſtick together, you will eaſily

eaſily believe, their Aggregate will prove too heavy or unwieldy for avolation. And to ſhew, that the fire may effect a lævigation in the ſurfaces of ſome corpuſcles, I have ſometimes cauſed *Minium*, and ſome other *calces*, that I judged convenient, to be melted for a competent time, in a vehement fire conveniently adminiſtred; whereby, according to expectation, that which was before a dull and incoherent powder, was reduced into much groſſer corpuſcles, multitudes of whoſe grains appeared ſmooth, glittering, and almoſt ſpecular, like thoſe of fine litharge of gold; and the maſſes that theſe grains compoſed, were uſually ſolid enough and of difficult fuſion. And when we make glaſs of Lead *per ſe*, (which I elſewhere teach you how to doe,) 'tis plain, that the particles of the Lead are reduced to a great ſmoothneſs; ſince, whereſoever you break the glaſs, the ſurfaces, produced at the crack, will not be jagged, but ſmooth, and conſiderably ſpecular.

lar. Nor do I think it impossible, that, even when the fire does not make any great attrition of the Corpuscles of the body to be fixt, it may yet occasion their sticking together, because by long tumbling them up and down in various manners, it may at length, after multitudes of revolutions and differing occursions, bring those of their surfaces together, which, by reason of their breadth, smoothness, or congruity of figure, are fit for mutual cohesion; and when once they come to stick, there is no necessity, that the same causes, that were able to make them pass by one another, when their contact was but according to an inconsiderable part of their surfaces, should have the same effect now, when their contact is full; though perhaps, if the degree of fire were much increased, a more vehement agitation would surmount this cohesion, and dissipate again these clusters of coalescent corpuscles.

These conjectures will perhaps appear

pear less extravagant, if you consider what happens in the preparation of Quick-silver præcipitated *per se*. For there, running Mercury, being put into a conveniently shaped Glass, is exposed to a moderate fire for a considerable time: (For I have sometimes found six or seven weeks to be too short a one.) In this degree of fire the parts are variously tumbled, and made many of them to ascend, till convening into drops on the sides of the glass, their weight carries them down again; but at length, after many mutual occursions, if not also attritions, some of the parts begin to stick together in the form of a red powder, and then more and more Mercurial particles are fastened to it, till at length all, or by much the greater part of the Mercury, is reduced into the like *Præcipitate*, which, by this cohesion of the parts, being grown more fixt, will not with the same degree of Heat be made to rise and circulate, as the Mercury would before; and yet, as I elsewhere note,

I have

I have found by trial, that, with a greater and competent degree of heat, this *Præcipitate per ſe*, would, without the help of any volatilizing additament, be eaſily reduced into running Mercury again. Chymiſts and Phyſicians, who agree in ſuppoſing this *Præcipitate* to be made without any additament, will perchance ſcarce be able to give a more likely account of the conſiſtency and degree of Fixity that is obtained in the Mercury; in which, ſince no body is added to it, there appears not to be wrought any but a *Mechanical* change. And though, I confeſs, I have not been without ſuſpicions, that in Philoſophical ſtrictneſs this *Præcipitate* may not be made *per ſe*, but that ſome penetrating igneous particles, eſpecially ſaline, may have aſſociated themſelves with the Mercurial Corpuſcles; yet even upon this ſuppoſition it may be ſaid, that theſe particles contribute to the effect that is produced, but by facilitating or procuring, by their opportune

tune Interpoſition, the mutual Cohe-
ſion of Corpuſcles that would not
otherwiſe ſtick to one another.

Perhaps it will not be altogether impertinent to add, on this occaſion, that, as for the generality of Chymiſts, as well others as *Helmontians*, that aſſert the Tranſmutation of all metalls into Gold by the Philoſopher's Stone, me thinks, they may grant it to be probable, that a new and fit Contexture of the parts of a volatile body may, eſpecially by procuring a full contact among them, very much contribute to make it highly fixt. For, to omit what is related by leſs credible Authours, 'tis averred, upon his own trial, by *Helmont*, who pretended not to the Elixir, that a grain of the powder, that was given him, tranſmuted a pound (if I miſ-remember not) of running Mercury; where the proportion of the Elixir to the Mercury was ſo inconſiderable, that it cannot reaſonably be ſuppoſed, that every Corpuſcle of the Quick-ſilver, that before was volatile, was made extreamly

treamly fixt meerly by its Coalition with a particle of the powder, since, to make one grain suffice for this Coalition, the parts it must be divided into must be scarce conceivably minute, and therefore each single part not likely to be fixt it self, or at least more likely to be carried up by the vehemently agitated Mercury, than to restrain that from avolation; whereas, if we suppose the Elixir to have made such a commotion among the corpuscles of the Mercury, as (having made them perhaps somewhat change their figure, and expelled some inconvenient particles,) to bring them to stick to one another, according to very great portions of their surfaces, and intangle one another, it will not be disagreeable to the Mechanical Doctrine of Fixity, that the Mercury should endure the fire as well as Gold, on the score of its new Texture, which, supposing the story true, appears to have been introduced, by the new colour, specifick gravity, Indissolubleness in Aqua fortis,

fortis, and other Qualities wherein Gold differs from Mercury, especially Malleableness, which, according to our Notes about that Quality, usually requires that the parts, from whose union it results, be either hooked, branched, or otherwise adapted and fitted to make them take fast hold of one another, or stick close to one another. And since, in the whole mass of the factitious Gold, all save one grain must be materially the same body, which, before the projection was made, was Quicksilver, we may see how great a proportion of volatile matter may, by an inconsiderable quantity of fixing additament, acquire such a new Disposition of its parts, as to become most fixt. And however, this Instance will agree much better with the Mechanical Doctrine about Fixity, than with that vulgar Opinion of the Chymists, (wherewith 'twill not at all comply,) That if, in a mixture, the volatile part do much exceed the fixt, it will carry up that,

or at leaſt a good portion thereof, with it; and on the contrary. But though this Rule holds in many caſes, where there is no peculiar indiſpoſition to the effect that is aimed at; yet if the Mechanical affections of the bodies be ill ſuited to ſuch a purpoſe, our Philoſophical Experiment manifeſtly proves, that the Rule will not hold, ſince ſo great a multitude of grains of Mercury, in ſtead of carrying up with them one grain of the Elixir, are detained by it in the ſtrongeſt fire. And thus much for the firſt way of fixing Volatile Bodies.

CHAP. III.

THE *ſecond* way of producing *Fixity*, is by expelling, breaking, or otherwiſe diſabling thoſe volatile Corpuſcles that are too indiſpoſed to be fixt themſelves, or are fitted to carry up with them ſuch particles as would not, without their help, aſcend. That the Expulſion of

of ſuch parts is a proper means to make the aggregate of thoſe that remain more fixt, I preſume you will not put me ſolicitouſly to prove; and we have a manifeſt inſtance of it in *Soot*, where, though many active parts were by the violence of the fire and current of the air carried up together by the more volatile parts; yet, when Soot is well diſtilled in a Retort, a competent time being given for the extricating and avolation of the other parts, there will at the bottom remain a ſubſtance that will not now fly away, as it formerly did. And here let me obſerve, that the receſſe of the fugitive corpuſcles may contribute to the fixation of a body, not barely becauſe the remaining matter is freed from ſo many unfixt, if not alſo volatilizing, parts; but, as it may often happen, that upon their receſſe the pores or intervals, they left behind them, are filled up with more ſolid or heavy matter, and the body becomes, as more homogeneous, ſo more cloſe and compact. And

whereas I intimated, that, beſides the expulſion of unfit corpuſcles, they may be otherwiſe diſabled from hindering the fixation of the maſſe they belong to, I did it, becauſe it ſeems very poſſible, that in ſome caſes they may, by the action of the fire, be ſo broken, as with their fragments to fill up the pores or intervals of the body they appertained to; or may make ſuch coalitions with the particles of a convenient additament, as to be no impediment to the Fixity of the whole maſſe, though they remain in it. Which poſſibly you will think may well happen, when you ſhall have peruſed the Inſtances annext to the *fourth* way of fixing bodies.

The *third* means of fixing, or leſſening the Volatility of, bodies, is by preſerving that reſt among the parts, whoſe contrary is neceſſary to their Volatilization. And this may be done by preventing or checking that Heat, or other motion, which external Agents ſtrive to introduce into

into the parts of the propoſed body. But this means tending rather to hinder the actual avolation of a portion of matter, or, at moſt, procure a temporary abatement of its volatility, than to give it a ſtable fixity, I ſhall not any longer inſiſt on it.

The *fourth* way of producing Fixity in a body, is by putting to it ſuch an appropriated Additament, whether *fixt* or *volatile*, that the Corpuſcles of the body may be put among themſelves, or with thoſe of the additament, into a complicated ſtate, or intangled contexture. This being the uſual and principal way of producing Fixity, we ſhall dwell ſomewhat the longer upon it, and give Inſtances of ſeveral degrees of Fixation. For, though they do not produce that quality in the ſtricteſt acceptation of the word, *Fixity*; yet 'tis uſefull in our preſent inquiry, to take notice, by what means that volatility comes to be *gradually* abated, ſince that may facilitate our underſtanding, how the Volatility

of a body comes to be *totally* abated, and consequently the body to be fixt.

CHAP. IV.

AND *first* we find, that a fixt additament, if its parts be conveniently shaped, may easily give a degree of fixity to a very volatile body. Thus *Spirit of Nitre*, that will of it self easily enough fly away in the Air, having its saline particles associated with those of *fixt Nitre*, or *salt* of *Tartar*, will with the Alkaly compose a salt of a Nitrous nature, which will endure to be melted in a Crucible without being deprived even of its Spirits. And I have found, that the spirits of Nitre, that abound in *Aqua fortis*, being concoagulated with the Silver they corrode, though one would not expect that such subtile Corpuscles should stick fast to so compact and solid a body as Silver; yet Crystalls, produced by their Coali-

Coalition, being put into a Retort, may be kept a pretty while in fusion, before the metal will let go the Nitrous spirits. When we poured *Oil* of Vitriol upon the *Calx* of Vitriol, though many Phlegmatick and other Sulphureous particles were driven away by the excited Heat; yet the saline parts, that combined with the fixt ones of the Colcothar, stuck fast enough to them, not to be easily driven away. And if *Oil of Vitriol* be in a due proportion dropt upon *Salt of Tartar*, there results a *Tartarum vitriolatum*, wherein the acid and alkalizate parts cohere so strongly, that 'tis not an ordinary degree of fire will be able to disjoyn them. Insomuch that divers Chymists have (though very erroniously) thought this compounded Salt to be indestructible. But a less heavy liquour than the ponderous Oil of Vitriol may by an Alkaly be more strongly detained than that Oil it self; experience having assured me, that *Spirit of Salt* being dropt to satiety upon a *fixt*

Alkaly, (I used either that of Nitre or of Tartar,) there would be made so strict an union, that, having, without additaments, distilled the resulting salt with a strong and lasting fire, it appeared not at all considerably to be wrought upon, and was not so much as melted.

But 'tis not the bare Mixture or Commistion of Volatile particles with Fixt ones, (yea though the former be predominant in quantity,) that will suffice to elevate the latter. For, unless the figures of the latter be congruous and fitted to fasten to the other, the volatile parts will fly away in the Heat, and leave the rest as fixt as before: as when sand or ashes are wetted or drenched with water, they quickly part with that water, without parting with any degree of their Fixity. But on the other side, it is not always necessary, that the body, which is fitted to destroy, or much abate, the volatility of another substance, should be it self fixt. For, if there be a skilful

or

or lucky coaptation of the figures of the particles of both the bodies, theſe particles may take ſuch hold of one another, as to compoſe corpuſcles, that will neither by reaſon of their ſtrict union be divided by Heat; nor by reaſon of their reſulting groſsneſs be elevated even by a ſtrong fire, or at leaſt by ſuch a degree of Heat as would have ſufficed to raiſe more indiſpoſed bodies than either of the ſeparate Ingredients of the mixture. This obſervation, if duly made out, does ſo much favour our Doctrine about the *Mechanical* Origine of Fixation, and may be of ſuch uſe, not onely to *Chymiſts*, in ſome of their operations, but to *Philoſophers*, in aſſigning the cauſes of divers *Phænomena* of Nature, that it may be worth while to exemplifie it by ſome Inſtances.

The firſt whereof I ſhall take from an uſual practice of the Chymiſts themſelves: which I the rather doe, to let you ſee, that ſuch known Experiments are too often over-looked by

by them that make them, but yet may hint or confirm Theories to those that reflect on them. The Instance, I here speak of, is that which is afforded by the vulgar Preparation of *Bezoardicum Minerale*. For, though the rectified *Butter* or Oil of *Antimony* and the *Spirit* of *Nitre*, that are put together to make this white *Præcipitate*, are both of them distilled liquours; yet the copious powder, that results from their Union, is, by that Union of volatile parts, so far fixt, that, after they have edulcorated it with water, they prescribe the calcining of it in a Crucible for five or six hours: which operation it could not bear, unless it had attained to a considerable fixation. This discourse supposes with the generality of Chymists, that the addition of a due quantity of spirit of Nitre, is necessary to be employed in making the *Bezoardicum Minerale*. But if it be a true Observation, which is attributed to the Learned *Guntherus Billichius*, (but which I had no Furnace at

at hand to examine when I heard of it,) if, I ſay, it be true, that a *Bezoardicum Minerale* may be obtained, without ſpirit of Nitre, barely by a ſlow evaporation, made in a Glaſſe-diſh, of the more fugitive parts of the Oil of Antimony; this Inſtance will not indeed be proper in this place, but yet will belong to the *ſecond* of the foregoing ways of introducing Fixity. I proceed now to alleage other particulars in favour of the above-mentioned Obſervation.

If you take ſtrong *Spirit* of *Salt*, that, when the Glaſs is unſtopt, will ſmoak of it ſelf in the cold air, and ſatiate it with the volatile *Spirit* of *Urine*, the ſuperfluous moiſture being abſtracted, you will obtain by this preparation (which, you may remember, I long ſince communicated to you, and divers other *Virtuoſi*,) a compounded Salt, ſcarce, if at all, diſtinguiſhable from *Sal Armoniac*, and which will not, as the Salts it conſiſts of will doe, before their coalition, eaſily fly up of it ſelf into the air,

air, but will require a not despicable degree of fire to sublime it.

Of these semivolatile Compositions of Salt I have made, and elsewhere mentioned, others, which I shall not here repeat, but passe on to other Instances pertinent to our present design.

I lately mentioned, that the Volatility of the spirits of Nitre may be very much abated, by bringing them to coagulate into Crystalls with particles of corroded Silver; but I shall now add, that I guessed, and by trial found, that these Nitrous spirits may be made much more fixt by the addition of the Spirit of Salt, which, if it be good, will of it self smoak in the Air. For, having dissolved a convenient quantity of Crystalls of Silver in distilled water, and precipitated them, not with a *Solution* of Salt, but the *Spirit* of Salt; the phlegm being abstracted, and some few of the looser saline particles; though the remaining masse were prest with a violent fire that kept the

the Retort red-hot for a good while; yet the Nitrous and Saline ſpirits would by no means be driven away from the Silver, but continued in fuſion with it; and when the maſſe was taken out, theſe Spirits did ſo abound in it, that it had no appearance of a Metal, but looked rather like a thick piece of Horn.

The next Inſtance I ſhall name is afforded us by that kind of *Turbith*, which may be made by *Oil of Vitriol*, in ſtead of the *Aqua fortis* imployed in the common *Turpethum Minerale*. For, though Oil of Vitriol be a diſtilled liquour, and Mercury a body volatile enough; yet, when we abſtracted four or five parts of Oil of Vitriol from one of Quick-ſilver, (eſpecially if the operation were repeated,) and then waſhed off as much as we could of the ſaline particles of the Oil of Vitriol; yet thoſe that remained adhering to the Mercury made it far more fixt, than either of the liquours had been before, and inabled it even in a Crucible to endure ſuch a degree

of

of fire, before it could be driven away, as, I confeſs, I ſomewhat wondered at. The like *Turbith* may be made with Oil of Sulphur *per Campanam*. But this is nothing to what *Helmont* tells us of the operation of his *Alkaheſt*, where he affirms, that that *Menſtruum*, which is volatile enough, being abſtracted from running Mercury, not onely coagulates it, but leaves it fixt, ſo that it will endure the brunt of fires acuated by Bellows, (*omnem follium ignem.*) If this be certain, it will not be a ſlender proof, that *Fixity* may be *Mechanically* produced; and however, the Argument will be good in reference to the *Helmontian* Spagyriſts. For if, as one would expect, there do remain ſome particles of the *Menſtruum* with thoſe of the metal, it will not be denied, that two volatile ſubſtances may perfectly fix one another. And if, as *Helmont* ſeems to think, the *Menſtruum* be totally abſtracted, this ſuppoſition will the more favour our Doctrine about *Fixity*; ſince, if there

there be no material additament left with the Quick-ſilver, the Fixation cannot ſo reaſonably be aſcribed to any thing, as to ſome new Mechanical modification, and particularly to ſome change of Texture introduced into the Mercury it ſelf.

And that you may think this the leſs improbable, I will now proceed to ſome Inſtances, whereof the firſt ſhall be this; That, having put a mixture made of a certain proportion of two dry, as well as volatile, bodies, (*viz.* Sal Armoniac, and Flower or very fine powder of Sulphur,) to half its weight of common running Mercury, and elevated this mixture three or four times from it, (in a conveniently ſhaped, and not over-wide, glaſs) the Mercury, that lay in the bottom in the form of a ponderous and ſomewhat purpliſh powder, was, by this operation, ſo fixt, that it long endured a ſtrong fire, which at length was made ſo ſtrong, that it melted the Glaſs, and kept it melted, without being ſtrong enough to force up the Mer-

Mercury: which, by ſome trials, not ſo proper to be here mentioned, ſeemed to have its ſalivating and emetick powers extraordinarily infringed, and ſometimes quite ſuppreſſed. But this onely upon the bye. In all the other Inſtances, (wherewith I ſhall conclude theſe Notes,) I ſhall employ one *Menſtruum*, Oil of Vitriol, and ſhew you the efficacy of it in fixing ſome parts of volatile bodies with ſome parts of it ſelf; by which examples it may appear, that a Volatile body may not onely leſſen the volatility of another body, as in the lately mentioned caſe of our ſpirituous *Sal Armoniac*; but that two Subſtances, that apart were volatile, may compoſe a third, that will not onely be leſs volatile, but conſiderably (if not altogether) fixt.

We mixed then, by degrees, about equal parts of *Oil* of *Vitriol* and *Oil* of *Turpentine*: and though each of them ſingle, eſpecially the latter, will aſcend with a moderate fire in a Sand-furnace; yet, after the Diſtillation

lation was ended, we had a considerable quantity, sometimes (if I misremember not) a fifth or sixth part, of a *Caput Mortuum* black as a Coal, and whereof a great part was of a scarce to be expected fixtness in the fire.

To give a higher proof of the disposition, that Oil of Vitriol has to let some of its parts grow fixt by combination with those of an exceeding volatile additament, I mixed this liquour with an equal or double weight of highly rectified *Spirit of Wine*, and not onely after, but sometimes without, previous digestion, I found, that the fluid parts of the mixture being totally abstracted, there would remain a pretty quantity of a black Substance so fixt as to afford just cause of wonder.

And because *Camphire* is esteemed the most fugitive of consistent bodies, in regard that, being but laid in the free air, without any help of the fire, it will fly *all* away; I tried, what Oil of Vitriol abstracted from

Camphire would doe; and found at the bottom of the Retort a greater quantity than one would expect of a Substance as black as pitch, and almost as far from the volatility as from the colour of Camphire, though it appeared not, that any of the Gum had sublim'd into the neck of the Retort.

From all which Instances it seems manifestly enough to follow, that in many cases there needs nothing to make associated particles, whether volatile or not, become fixt, but either to implicate or intangle them among themselves, or bring them to touch one another according to large portions of their surfaces, or by both these ways conjoyntly, or by some others, to procure the firm Cohæsion of so many particles, that the resulting Corpuscles be too big or heavy to be, by the degree of fire wherein they are said to be fixt, driven up into the Air.

FINIS.

Experiments and Notes
ABOUT THE
MECHANICAL ORIGINE
OR
PRODUCTION
OF
CORROSIVENESS
AND
CORROSIBILITY.

By the Honourable
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Experiments and Notes
ABOUT THE
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SECT. I.

About the Mechanical Origine of Corrosiveness.

I Do not in the following Notes treat of *Corrosiveness* in their ſtrict ſenſe of the word, who aſcribe this Quality only to Liquors, that are notably acid or ſowre, ſuch as *Aqua fortis*, Spirit of Salt, Vinegar,

Ju'ce of Lemons, &c. but, that I may not be oblig'd to overlook Urinous, Oleous, and divers other Solvents, or to coin new names for their differing Solutive Powers, I presume to employ the word *Corrosiveness* in a greater latitude, so as to make it almost equivalent to the *Solutive* power of Liquors, referring other Menstruums to those that are Corrosive or fretting, (though not always as to the most proper, yet) as to the principal and best known *species*; which I the less scruple here to do, because I have * elsewhere more distinctly enumerated and sorted the Solvents of bodies.

* This refers to an Essay of the Authors about the Usefulness of Chymistry to, &c.

The Attributes that seem the most proper to qualifie a Liquor to be Corrosive, are all of them Mechanical, being such as are these that follow:

First, That the Menstruum consist of, or abound with, Corpuscles not too

too big to get in at the Pores or Commissures of the body to be dissolved; nor yet be so very minute as to pass through them, as the beams of Light do through Glass; or to be unable by reason of their great slenderness and flexibility to disjoyn the parts they invade.

Secondly, That these Corpuscles be of a shape fitting them to insinuate themselves more or less into the Pores or Commissures above-mentioned, in order to the dissociating of the solid parts.

Thirdly, That they have a competent degree of solidity to disjoyn the Particles of the body to be dissolved; which Solidity of Solvent corpuscles is somewhat distinct from their bulk, mention'd in the first Qualification; as may appear by comparing a stalk of Wheat and a metalline Wire of the same *Diameter*, or a flexible wand of Osier of the bigness of ones little finger, with a rigid rod of Iron of the same length and thickness.

Fourthly, That the Corpuſcles of the Menſtruum be agile and advantaged for motion, (ſuch as is fit to disjoyn the parts of the invaded body) either by their ſhape, or their minuteneſs, or their fitneſs to have their action befriended by adjuvant Cauſes; ſuch as may be (*firſt*) the preſſure of the Atmoſphere, which may impell them into the Pores of bodies not fill'd with a Subſtance ſo reſiſting as common Air: As we ſee, that water will by the prevalent preſſure of the Ambient, whether Air or Water, be raiſed to the height of ſome inches in capillary Glaſſes, and in the pores of Spunges, whoſe conſiſtent parts being of eaſier ceſſion than the ſides of Glaſs-pipes, thoſe Pores will be enlarged, and conſequently thoſe ſides disjoyn'd, as appears by the dilatation and ſwelling of the Spunge: And (*ſecondly*) the agitation, that the intruding Corpuſcles may be fitted to receive in thoſe Pores or Commiſſures by the tranſcurſion of ſome

ſubtile

subtile ethereal matter; or by the numerous knocks and other pulses of the swimming or tumbled Corpuscles of the Menstruum it self,(which being a fluid body, must have its small parts perpetually and variously moved) whereby the engaged Corpuscles, like so many little Wedges and Leavers, may be enabled to wrench open, or force asunder the little parts between which they have insinuated themselves. But I shall not here prosecute this Theory, (which, to be handled fully, would require a discourse apart) since these Conjectures are propos'd but to make it probable in the general, That the *Corrosiveness* of bodies may be deduced from Mechanical Principles: But whether best from the newly propos'd ones, or any other, need not be anxiously consider'd in these Notes, where the things mainly intended and rely'd on, are the Experiments and *Phænomena* themselves.

EXPER. I.

'Tis obvious, that, though the recently expreſt Juice of Grapes be ſweet, whilſt it retains the Texture that belongs to it as 'tis new, (eſpecially if it be made of ſome ſorts of Grapes that grow in hot Regions,) yet after fermentation, 'twill, in tract of time, as 'twere ſpontaneouſly, degenerate into Vinegar. *In which* Liquor, to a multitude of the more ſolid Corpuſcles of the Muſt, their frequent and mutual Attritions may be ſuppoſed to have given edges like thoſe of the blades of ſwords or knives; and *in which*, perhaps, the confuſed agitation that preceded, extricated, or, as it were, unſheathed ſome acid particles, that (deriv'd from the ſap of the Vine, or, perchance more originally, from the juice of the Earth) were at firſt in the Muſt, but lay conceal'd, and as it were ſheathed, among

among the other particles wherewith they were associated, when they were prest out of the Grapes. Now this Liquor, that by the forementioned (or other like) Mechanical Changes is become Vinegar, does so abound with Corpuscles, which, on the account of their edges, or their otherwise sharp and penetrative shape, are Acid and Corrosive, that the better sort of it will, without any preparation, dissolve Coral, Crabs-eyes, and even some Stones, *Lapis stellaris* in particular, as also *Minium*, (or the *Calx* of Lead) and even crude Copper, as we have often tried. And not onely the distill'd Spirit of it will do those things more powerfully, and perform some other things that meer Vinegar cannot; but the saline particles, wont to remain after Distillation, may, by being distill'd and cohobated *per se*, or by being skilfully united with the foregoing Spirit, be brought to a *Menstruum* of no small efficacy in the dissolution, and

and other preparations of metalline bodies, too compact for the meer Spirit it ſelf to work upon.

From divers other ſweet things alſo may Vinegar be made; and even of Honey, skilfully fermented with a ſmall proportion of common water, may be made a Vinegar ſtronger than many of the common Wine-vinegars; as has been affirmed to me by a very candid Phyſician, who had occaſion to deal much in Liquors.

EXPER. II.

NOt onely ſeveral dry Woods, and other Bodies that moſt of them paſs for inſipid, but Honey and Sugar themſelves afford by Diſtillation Acid Spirits that will diſſolve Coral, Pearls, &c. and will alſo corrode ſome Metals and metalline Bodies themſelves; as I have often found by Trial. So that the violent Operation of the fire, that deſtroys

stroys what they call the *Form* of the distill'd body, and works as a Mechanical Agent by agitating, breaking, dissipating, and under a new constitution reassembling the parts, procures for the Distiller an Acid Corrosive Menstruum; which *whether* it be brought to pass by making the Corpuscles rub one another into the figure of little sharp blades, *or* by splitting some solid parts into sharp or cutting Corpuscles, *or* by unsheathing, as it were, some parts, that, during the former Texture of the body, did not appear to be acid; *or* whether it be rather effected by some other Mechanical way, may in due time be further considered.

EX-

EXPER. III.

'Tis obſerv'd by Refiners, Goldſmiths and Chymiſts, that *Aqua Fortis* and *Aqua Regia*, which are Corroſive Menſtruums, diſſolve Metals, the former of them Silver, and the latter Gold, much more ſpeedily and copiouſly when an external heat gives their inteſtine motions a new degree of Vehemency or Velocity, which is but a mechanical thing; and yet this ſuperadded meaſure of Agitation is not onely in the abovemention'd Inſtances a powerfully aſſiſtant Cauſe in the Solutions made by the lately mention'd Corroſive Liquors, but is that without which ſome Menſtruums are not wont ſenſibly to corrode ſome bodies at all, as we have tried in keeping Quick-ſilver in three or four times its weight of Oyl of Vitriol; ſince in this Menſtruum I found not the Mercury to be diſſolved or corroded,

roded, though I kept it a long time in the Cold: Whereas, when the Oyl of Vitriol was excited by a convenient heat, (which was not faint) it corroded the Mercury into a fine white *Calx* or powder, which, by the affusion of fair water, would be presently turn'd into a yellowish *Calx* of the colour and nature of a Turbith. I remember also, that having for trials sake dissolv'd in a weak Spirit of Salt, a fourth part of its weight of fine Crystals of Nitre, we found, that it would not in the cold (at least during a good while that we waited for its operation) dissolve Leaf-gold; but when the *Menstruum* was a little heated at the fire, the Solution proceeded readily enough. And in some cases, though the external heat be but small, yet there may intervene a brisk heat, and much cooperate in the dissolution of a Body; as, for instance, of Quicksilver in *Aqua Fortis*. For it is no prodigy to find, that when a full proportion of that fluid Metal has been

been taken, the Solution, though at first altogether liquid, and as to sense uniform, comes to have after a while a good quantity of coagulated or crystalliz'd matter at the bottom, of which the cause may be, that in the very act of Corrosion there is excited an intense degree of heat, which conferring a new degree of agitation to the Menstruum, makes it dissolve a good deal more, than afterwards, when the Conflict is over, it is able to keep up.

EXPER. IV.

WE have observed also, that Agitation does in some cases so much promote the Dissolutive power of Saline bodies, that though they be not reduc'd to that subtilty of parts, to which a strong Distillation brings them; yet they may in their grosser and cruder form have the power to work on Metals; as I elsewhere shew, that by barely boiling

ing some Solutions of Salts of a convenient structure, as Nitre, Sal Armoniac, &c. with foliated Gold, Silver, &c. we have corroded these Metals, and can dissolve some others. And by boiling crude Copper (in Filings) with Sublimate and common water, we were able, in no long time, to make a Solution of the Metal.

EXPER. V.

SOmetimes also, so languid an Agitation, as that which seems but sufficient to keep a Liquor in the state of fluidity, may suffice to give some dry bodies a corroding power, which they could not otherwise exercise; as in the way of writing ones name (or a *Motto*) upon the blade of a knife with common Sublimate: For, if having very thinly overlaid which side you please with Bees-wax, you write with a bodkin or some pointed thing upon it; the Wax

Wax being thereby removed from the ſtrokes made by the ſharp body, 'tis eaſie to etch with Sublimate; ſince you need but ſtrew the powder of it upon the place bared of the Wax, and wet it well with meer common water; for ſtrong Vinegar is not neceſſary. For after a while all the parts of the blade that ſhould not be fretted, being protected by the Caſe or Film of Wax, the Sublimate will corrode onely where way has been made for it by the bodkin, and the Letters will be more or leſs deeply ingraven (or rather etch'd) according to the time the Sublimate is ſuffer'd to lye on. And if you aim onely at a legible impreſſion, a few minutes of an hour (as four or five) may ſerve the turn.

EX-

EXPER. VI.

THis brings into my mind an Observation I have sometimes had occasion to make, that I found more useful than common, and it is, That divers Bodies, whether distill'd or not distill'd, that are not thought capable of dissolving other Bodies, because in moderate degrees of heat they will not work on them, may yet by intense degrees of heat be brought to be fit Solvents for them. To which purpose I remember, that having a distill'd Liquor, which was rather sweet to the taste, than either acid, lixiviate or urinous, though for that reason it seem'd unfit to work on Pearls, and accordingly did not dissolve them in a considerable time, wherein they were kept with it in a more than ordinarily warm digestion; yet the Glass being for many hours (amounting perhaps to some days) kept in such

an heat of ſand as made the Liquor boil, we had a Diſſolution of Pearls, that uniting with the Menſtruum made it a very valuable Liquor. And though the Solvents of crude Gold, wont to be employed by Chymiſts, are generally diſtill'd Liquors that are acid, and in the lately mention'd Solvent, made of crude Salts and common water, Acidity ſeem'd to be the predominant quality (which makes the uſe of Solutions made in *Aqua Regia*, &c. ſuſpected by many Phyſicians and Chymiſts;) yet fitly choſen Alcalizate Bodies themſelves, as repugnant as they uſe to be to Acids, without the help of any Liquor will be enabled by a melting Fire in no long time to penetrate and tear aſunder the parts even of crude Gold; ſo that it may afterwards be eaſily taken up in Liquors that are not acid, or even by water it ſelf.

EX-

EXPER. VII.

THe Tract about Salt-peter, that gave occasion to these Annotations, may furnish us with an eminent Instance of the Production of Solvents. For, though pure Salt-peter it self, when dissolv'd in water, is not observ'd to be a Menstruum for the Solution of the Metals hereafter to be named, or so much as of Coral it self; yet, when by a convenient Distillation its parts are split, if I may so speak, and by Attrition, or other Mechanical ways of working on them, reduc'd to the shapes of Acid and Alcalizate Salts, it then affords two sorts of Menstruums of very differing natures, which betwixt them dissolve or corrode a great number and variety of Bodies; as the Spirit of Nitre without addition is a Solvent for most Metals, as Silver, Mercury, Copper, Lead, &c. and also divers Mineral Bodies, as-

Tin-glass, Spelter, *Lapis Calaminaris*, &c. and the fixed Salt of Nitre operates upon Sulphureous Minerals, as common Sulphur, Antimony, and divers other Bodies, of which I elsewhere make mention.

EXPER. VIII.

BY the former Trials it has appear'd, that the increase of Motion in the more penetrating Corpuscles of a Liquor, contributes much to its Solutive power; and I shall now adde, that the Shape and Size, which are Mechanical affections, and sometimes also the Solidity of the same Corpuscles does eminently concur to qualifie a Liquor to dissolve this or that particular body. Of this, even some of the more familiar practices of Chymists may supply us with Instances. For there is no account so probable as may be given upon this supposition, why *Aqua Fortis*, which will dissolve Silver, without medling

medling with Gold, should, by the addition of a fourth part of its weight of Sal Armoniac, be turn'd into *Aqua Regia*, which, without medling with Silver, will dissolve Gold. But there is no necessity of having recourse to so gross and compounded a Body as Sal Armoniac to enable *Aqua Fortis* to dissolve Gold: For, the Spirit of common Salt alone being mingled in a due proportion, will suffice for that purpose. Which (by the way) shews, that the Volatile Salt of Urine and Soot, that concur to the making up of Sal Armoniac, are not necessary to the dissolution of Gold, for which a Solvent may be made with *Aqua Fortis* and crude Sea-salt. I might adde, that the Mechanical affections of a *Menstruum* may have such an interest in its dissolutive power, that even Mineral or Metalline Corpuscles may become useful Ingredients of it, though perhaps it be a distill'd Liquor; as might be illustrated by the Operations of some compounded Solvents, such as

is the Oyl of Antimony made by repeated Rectifications of what Chymists call its *Butter*, which, whatever some say to the contrary, does much abound in Antimonial Substance.

EXPER. IX.

BUt I shall return to our *Aqua Regia*, because the mention I had occasion to make of that Solvent brought into my mind what I devis'd, to make it probable, that a smaller change, than one would lightly imagine, of the bulk, shape, or solidity of the Corpuscles of a Menstruum may make it fit to dissolve a Body it would not work on before. And this I the rather attempted, because the warier sort of Chymists themselves are very shye of the inward use or preparations made of Gold by the help of *Aqua Fortis*, because of the odious stink they find, and the venenosity they suspect

suspect in that corrosive Menstruum: Whereas Spirit of Salt we look upon as a much more innocent Liquor, whereof, if it be but diluted with fair water or any ordinary drink, a good Dose may be safely given inwardly, though it have not wrought upon Gold or any other body, to take off its acrimony. But, whether or no this prove of any great use in Physick, wherein perhaps, if any quantity of Gold be to be dissolved, a greater proportion of Spirit of Nitre would be needed; the success will not be unfit to be mention'd in reference to what we were saying of Solvents. For, whereas we find not that our *Spirit* of *Salt* here in *England* will at all dissolve crude Gold, we found, that by putting some Leaf-gold into a convenient quantity of good Spirit of Salt, when we had dropt-in Spirit of Nitre (shaking the Glass at each drop,) till we perceived, that the mixture was just able in a moderate heat to dissolve the Gold, we found, that

we had been oblig'd to employ but after the rate of twelve drops of the latter Liquor to an ounce of the former; ſo that, ſuppoſing each of theſe drops to weigh a grain, the fortieth part of Spirit of Nitre being added, ſerved to turn the Spirit of Salt into a kind of *Aqua Regia*. But to know the proportion otherwiſe than by gheſs, we weigh'd ſix other drops of the ſame Spirit of Salt, and found them to amount not fully to three grains and an half: Whence it appeared, that we added but about a ſeventieth part of the Nitrous Spirit to that of Salt.

The Experiments that have been hitherto recited, relate chiefly to the Production of Corroſive Menſtruums; and therefore I ſhall now adde an account of a couple of Trials, that I made manifeſtly to leſſen or quite to deſtroy Corroſiveneſs in Liquors very conſpicuous for that quality.

EX-

EXPER. X.

WHereas one of the most corrosive Menstruums, that is yet known, is *Oyl of Vitriol*, which will fret in pieces both divers Metals and Minerals, and a great number and variety of animal and vegetable bodies; yet if you digest with it for a while onely an equal weight of highly rectified Spirit of Wine, and afterwards distill the mixture very warily, (for else the Experiment may very easily miscarry,) you may obtain a pretty deal of Liquor not corrosive at all, and the remaining substance will be reduc'd partly *into* a Liquor, which, though acid, is not more so than one part of good Oyl of Vitriol will make ten times as much common water, by being well mingled with it; *and* partly *into* a dry substance that has scarce any taste at all, much less a corrosive one.

EX-

EXPER. XI.

AND though good *Aqua Fortis* be the most generally employed of corrosive Menstruums, as being capable of dissolving or corroding, not onely many Minerals, as Tinglass, Antimony, Zinke, &c. but all Metals except Gold, (for, though it make not a permanent Solution of crude Tin, it quickly frets the parts asunder, and reduces it to an immalleable substance;) yet to shew, how much the power of *corroding* may be taken away by changing the Mechanical Texture of a Menstruum, even without seeming to destroy the fretting Salts, I practis'd (and communicated to divers *Virtuosi*) the following Experiment, elsewhere mentioned to other purposes.

We took equal parts of good *Aqua Fortis*, and highly dephlegm'd Spirit of Wine, and having mingled them warily and by degrees, (with-

(without which caution the Operation may prove dangerous,) we united them by two or three Distillations of the whole mixture; which afterwards we found not to have the least fretting taste, and to be so deprived of its corrosive nature, that it would not work upon Silver, though by Precipitation or otherwise reduc'd to very small parts; nay, it would scarce sensibly work in a good while on Filings of Copper, or upon other bodies, which meer Vinegar, or perhaps Rhenish wine will corrode. Nay, I remember, that with another Spirit, (that was not Urinous) and afterwards with *Alkool* of Wine we shew'd a more surprizing *Specimen* of the power of either destroying or debilitating the Corrosiveness of a *Menstruum*, and checking its Operation. For, having caused a piece of Copper-plate to be put into one ounce of *Aqua Fortis*, when this Liquor was eagerly working upon the Metal, I caus'd an ounce of the *Alkool* of Wine, or the

the other Spirit to be poured, (which it ſhould warily be) upon the agitated mixture; whoſe effervescence, at the firſt inſtant, ſeemed to be much increaſed, but preſently after was checked, and the Corroſiveneſs of the Menſtruum being ſpeedily diſabled or corrected, the remaining Copper was left undiſſolved at the bottom.

Nor are theſe the onely acid Menſtruums that I have many years ſince been able to correct by ſuch a way: For I applied it to others, as Spirit of Nitre, and even *Aqua Regis* it ſelf; but it has not an equal operation upon all, and leaſt of all (as far as I can remember) upon Spirit of Salt; as on the other ſide ſtrong Spirit of Nitre was the *Menſtruum* upon which its effects were the moſt ſatisfactory.

Moſt of the Chymiſts pretend, that the Solutions of bodies are perform'd by a certain Cognation and Sympathy between the Menſtruum and the body it is to work upon.

And

And it is not to be denied, that in divers Instances there is, as it were, a Consanguinity between the Menstruum and the body to be dissolved; as when Sulphur is dissolved by Oyls whether exprest or distill'd: But yet, as the opinion is generally proposed, I cannot acquiesce in it; partly becaus there are divers Solutions and other *Phænomena*, where it will not take place, and partly becaus even in those instances wherein 'tis thought most applicable, the effect seems to depend upon Mechanical Principles.

EXPER. XII.

AND first, 'twill be difficult to shew, what Consanguinity there is between Sal Gem, and Antimony, and Iron, and Zinke, and Bread, and Camphire, and *Lapis Calaminaris*, and flesh of divers kinds, and Oister-shells, and Harts-horn, and Chalk, and Quick-lime; some of which belong

ong to the Vegetable, ſome to the Mineral, and ſome to the Animal Kingdom; and yet all of them and divers others (as I have tried) may, even without the aſſiſtance of external Heat, be diſſolved or corroded by one ſingle Mineral Menſtruum, Oyl of Vitriol. And which is not to be neglected on this occaſion, ſome of them may be bodies, ſuppoſed by Chymiſts to have an Antipathy to each other in point of Corroſion or Diſſolution.

EXPER. XIII.

I Obſerve alſo, that a Diſſolution may be made of the ſame body by *Menſtruums*, to which the Chymiſts attribute (as I juſt now obſerved they did to ſome Bodies) a mutual Antipathy, and which therefore are not like to have a Sympathy with the ſame third body; as I found by trial, that both *Aqua Fortis*, and Spirit of Urine, upon whoſe mixture

ture there insues a conflict with a great effervescence, will each of them apart readily dissolve crude Zinke, and so each of them will, the Filings of Copper. Not to mention, that pure Spirit of Wine and Oyl of Vitriol, as great a difference as there is between them, in I know not how many respects, and as notable a heat as will insue upon their Commixture, will each of them dissolve Camphire; to which may be added other instances of the like nature. As for what is commonly said, that Oyls dissolve Sulphur, and Saline Menstruums Metals, because (as they speak) *Simile simili gaudet*: I answer, That where there is any such similitude, it may be very probably ascribed, not so much, with the Chymists that favour *Aristotle*, to the essential forms of the bodies that are to work on each other, nor, with the meer Chymists, to their Salt, or Sulphur, or Mercury, as such; but to the congruity between the pores and figures of the Menstruum, and the

the body dissolved by it, and to some other Mechanical Affections of them.

EXPER. XIV.

FOr Silver, for example, not onely will be dissolved by Nitre which they reckon a Salt, but be amalgam'd with, and consequently dissolved by, Quicksilver, and also by the operation of Brimstone, be easily incorporated with that Mineral which Chymists are wont to account of so oleaginous a nature, and insoluble in *Aqua Fortis*.

EXPER. XV.

AND as for those Dissolutions that are made with Oylie and inflammable Menstruums, of common Sulphur and other inflammable bodies, the Dissolution does not make for them so clearly as they imagine.

imagine. For if such Menstruums operate, as is alledged, upon the account of their being, as well as the bodies they work upon, of a sulphureous nature, whence is it that highly rectified Spirit of Wine, which according to them must be of a *most Sulphureous* nature, since being set on fire 'twill flame all away without leaving one drop behind it, will not (unless perhaps after a tedious while) dissolve even Flowers of Brimstone, which essential as well as express'd Oyls will easily take up; as Spirit of Wine it self also will do almost in a trice, if (as we shall see anon) by the help of an Alcali the Texture of the Brimstone be alter'd, though the onely thing that is added to the Sulphur being an incombustible substance, is nothing near of so sulphureous a nature as the Flowers, and need have no Consanguinity upon the score of its Origine with Spirit of Wine, as 'tis alledged that Salt of Tartar has; since I have tried, That fixt Nitre,

employ'd instead of it, will do the same.

EXPER. XVI.

THe mention of *Nitre* brings into my mind, that the Salt-peter being wont to be lookt upon by Chymists as a very inflammable body, ought, according to them, to be of a very sulphureous nature; yet we find not that 'tis in Chymical Oyls, but in water, readily dissolved. And whereas Chymists tell us, that the Solutions of Alcaly's, such as Salt of Tartar, or of Potashes in common Oyls, proceed from the great cognation between them, I demand, whence it happens, that Salt of Tartar will by boiling be dissolved in the expresst Oyl of Almonds, or of Olives, and be reduc'd with it to a soapy body, and that yet with the essential Oyl of Juniper or Aniseeds, &c. where what they call the Sulphur is made pure and

and penetrant, being freed from the earthy, aqueous and feculent parts, which Distillation discovers to be in the expreſt Oyls, you may boil Salt of Tartar twenty times as long without making any Soap of them, or perhaps any ſenſible Solution of the Alkaly. And Chymiſts know, how difficult it is, and how unſucceſsfully 'tis wont to be attempted to diſſolve pure Salt of Tartar in pure Spirit of Wine, by digeſting the not peculiarly prepar'd Salt in the cognate Menſtruum. I will not urge, that, though the moſt conſpicuous mark of Sulphur be inflammability, and is in an eminent degree to be found in Oyl as well as Sulphur; yet an Alkaly and water which are neither ſingly, nor united inflammable, will diſſolve common Sulphur.

EXPER. XVII.

BUt to make it probable againſt the Chymiſts, (for I propoſe it but as an argument *ad hominem*) that the Solution of Sulphur in expreſt Oyls depends upon ſomewhat elſe beſides the abundance of the ſecond Principle in both the bodies; I will adde to what I ſaid before, an affirmation of divers Chymical Writers themſelves, who reckon *Aqua Regis*, which is plainly a Saline Menſtruum, and diſſolves Copper, Iron, Coral, &c. like Acid Liquors, among the Solvents of Sulphur, and by that power among other things diſtinguiſh it from *Aqua Fortis*. And on the other ſide if, there be a Congruity betwixt an expreſt Oyl and another body, though it be ſuch as, by its eaſie Diſſolubleneſs in Acid Salts, Chymiſts ſhould pronounce to be of a ſaline nature, an expreſt Oyl will readily enough work upon it,

it; as I have tried by digesting even crude Copper in Filings with Oyl of sweet Almonds, which took up so much of the metal as to be deeply coloured thereby, as if it had been a Corrosive Liquor: Nay, I shall adde, that even with Milk, as mild a Liquor as 'tis, I have found by Trial, that without the help of fire a kind of Dissolution may, though not in few hours, be made of crude Copper, as appear'd by the greenish blew colour the Filings acquired, when they had been well drenched in the Liquor, and left for a certain time in the Vessel, where the air had very free access to them.

EXPER. XVIII.

BEſides the Argument *ad hominem*, newly drawn from *Aqua Regia*, it may be proper enough to urge another of the ſame kind upon the generality of the *Helmontians* and *Paracelſians*, who admit what the Heads of their Sects deliver concerning the Operations of the *Alkaheſt*. For whereas 'tis affirm'd, that this irreſiſtible *Menſtruum* will diſſolve all tangible bodies here below, ſo as they may be reduc'd into inſipid water; as on the one ſide 'twill be very hard to conceive how a ſpecificated Menſtruum that is determin'd to be either Acid, or Lixiviate, or Urinous, &c. ſhould be able to diſſolve ſo great a variety of Bodies of differing and perhaps contrary natures, in ſome whereof Acids, in other Lixiviate Salts, and in others Urinous are predominant; ſo on the other ſide, if the *Alkaheſt* be not a ſpeci-

specificated Menstruum, 'twill very much disfavour the Opinion of the Chymists, that will have some Bodies dissoluble onely by Acids as such, others by fixt Alkalys, and others again by Volatile Salts; since a Menstruum, that is neither Acid, Lixiviate, nor Urinous, is able to dissolve bodies, in some of which one, and in others another of those Principles is predominant: So that, if a Liquor be conveniently qualified, it is not necessary that it should be either Acid to dissolve Pearl or Coral, or Alkalizate to dissolve Sulphur. But upon what Mechanical account an analyzing Menstruum may operate, is not necessary to be here determin'd. And I elsewhere offer some thoughts of mine about it.

EXPER. XIX.

IF we duly reflect upon the known proceſs that Chymiſts are wont to employ in making *Mercurius dulcis*, we ſhall find it very favourable to our *Hypotheſis*. For though we have already ſhewn in the V. Experiment, and 'tis generally confeſt, that common Sublimate made of Mercury is a highly corroſive body; yet, if it be well ground with near an equal weight of Quickſilver, and be a few times ſublimed, (to mix them the more exactly) it will become ſo mild, that 'twill not ſo much as taſte ſharp upon the tongue; ſo that Chymiſts are wont to call it *Mercurius dulcis*: And yet this Dulcification ſeems to be performed in a Mechanical way. For moſt part of the Salts, that made the Sublimate ſo Corroſive, abide in the *Mercurius dulcis*; but by being compounded with more Quickſilver, they

they are diluted by it, and (which is more conſiderable) acquire a new Texture, which renders them unfit to operate, as they did before, when the fretting Salts were not joyn'd with a ſufficient quantity of the Mercury to inhibit their corroſive activity. It may perhaps ſomewhat help us to conceive, how this change may be made, if we imagine, *that* a company of meer Knife-blades be firſt fitted with Hafts, which will in ſome regard leſſen their wounding power by covering or caſing them at that end which is deſign'd for the handle; (though their inſertion into thoſe Hafts, turning them into Knives, makes them otherwiſe the fitter to cut and pierce) and *that* each of them be *afterwards* ſheathed, (which is, as it were, a hafting of the Blades too;) for then they become unfit to cut or ſtab, as before, though the Blades be not deſtroyed: Or elſe we may conceive theſe Blades without Hafts or Sheaths to be tied up in bundles,

or

or as it were in little faggots with pieces of wood, ſomewhat longer than themſelves, opportunely placed between them. For neither in this new Conſtitution would they be fit to cut and ſtab as before. And by conceiving the edges of more or fewer of the Blades to be turn'd inwards, and thoſe that are not, to have more or leſs of their points and edges to be ſheath'd, or otherwiſe cover'd by interpos'd bodies, one may be help'd to imagine, how the genuine effects of the Blades may be variouſly leſſen'd or diverſifi'd. But, whether theſe or any other like changes of Diſpoſition be fancy'd, it may by Mechanical Illuſtrations become intelligible, how the Corroſive Salts of common Sublimate may loſe their efficacy, when they are united with a ſufficient quantity of Quickſilver in *Mercurius dulcis*: In which new ſtate the Salts may indeed in a Chymical phraſe be ſaid to be ſatiated; but this Chymical phraſe does not explicate

plicate how this Saturation takes away the Corroſiveneſs from Salts that are ſtill actually preſent in the ſweet Mercury. And by Analogy to ſome ſuch Explications as the above propos'd, a poſſible Account may be render'd, why fretting Salts do either quite loſe their ſharpneſs, as Alkalies, whilſt they are imbodied with Sand in common Glaſs; or loſe much of their Corroſive Acidity, as Oyl of Vitriol does when with Steel it compoſes *Vitriolum Martis*; or elſe are tranſmuted or diſguis'd by conjunction with ſome corroded bodies of a peculiar Texture, as when *Aqua Fortis* does with Silver make an extreamly bitter Salt or Vitriol, and with Lead one that is poſitively ſweet almoſt like common *Saccharum Saturni*.

EX-

EXPER. XX.

TO ſhew, how much the Efficacy of a Menſtruum may depend even upon ſuch ſeemingly ſlight Mechanical Circumſtances as one would not eaſily ſuſpect any neceſſity of, I ſhall employ an Experiment, which though the unpractis'd may eaſily fail of making well, yet, when I tried it after the beſt manner, I did it with good ſucceſs. I put then upon Lead a good quantity of well rectified *Aqua Fortis*, in which the Metal, as I expected, continued undiſſolved; though, if the Chymiſts ſay truly that the diſſolving power of the *Menſtruum* conſiſts onely in the acid Salts that it abounds with, it ſeems naturally to follow, that the more abundance of them there is in a determinate quantity of the Liquor, it ſhould be the more powerfully

fully able to dissolve Metalline and Mineral bodies: And in effect we see, that, if Corrosive Menstruums be not sufficiently dephlegmed, they will not work on divers of them. But, notwithstanding this plausible Doctrine of the Chymists, conjecturing that the Saline Particles that swam in our *Aqua Fortis* might be more throng'd together, than was convenient for a body of such a Texture of Saline parts, and such intervals between them, I diluted the Menstruum by adding to it what I thought fit of fair water, and then found, that the desired Congruity betwixt the Agent and the Patient emerged, and the Liquor quickly began to fall upon the Metal and dissolve it. And if you would try an Experiment to the same purpose, that needs much less circumspection to make it succeed, you may, instead of employing Lead, reiterate what I elsewhere mention my self to have tried with

Silver,

Silver, which would not diſſolve in too ſtrong *Aqua fortis*, but would be readily fallen upon by that Liquor, when I had weaken'd it with common water.

And this it may ſuffice to have ſaid at preſent of the power or faculty that is found in ſome bodies of Corroding or Diſſolving others. Whereof I have not found among the *Ariſtotelians*, I have met with, ſo much as an Offer at an Intelligible account. And I the leſs expect the vulgar Chymiſts will from their Hypoſtatical Principles afford us a Satisfactory one, when, beſides the Particulars that from the nature of the things and *Helmont*'s Writings have been lately alledg'd againſt their *Hypotheſis*, I conſider, how ſlight accounts they are wont to give us even of the familiar *Phænomena* of Corroſive Liquors. For if, for example, you ask a vulgar Chymiſt why *Aqua fortis* diſſolves Silver and Copper,

'tis

'tis great odds but he will tell you, 'tis because of the abundance of fretting Salt that is in it, and has a cognation with the Salts of the Metal. And if you ask him, why Spirit of Salt dissolves Copper, he will tell you 'tis for the same reason; and yet, if you put Spirit of Salt, though very strong, to *Aqua fortis*, this Liquor will not dissolve Silver, because upon the mixture, the Liquors acquire a new Constitution as to the Saline Particles, by vertue of which the mixture will dissolve, instead of Silver, Gold. Whence we may argue against the Chymists, that the Inability of this compounded Liquor to work on Silver does not proceed from its being weaken'd by the Spirit of Salt; as well because, according to them, Gold is far the more compact metal of the two, and requires a more potent Menstruum to work upon it, as because this same compounded Liquor will readily dissolve Copper. And to the same purpose

poſe with this Experiment I ſhould alledge divers others, if I thought this the fitteſt place wherein I could propoſe them.

SECT.

SECT. II.

About the Mechanicall Origine of CORROSIBILITY.

Corrosibility being the quality that answers *Corrosiveness*, he that has taken notice of the Advertisement I formerly gave about my use of the Term *Corrosiveness* in these Notes, may easily judge, in what sense I employ the name of the other Quality; which (whether you will stile it Opposite or Conjugate) for want of a better word, I call *Corrosibility*.

See the beginning of the first Section.

This *Corrosibility* of Bodies is as well as their Corrosiveness a Relative thing; as we see, that Gold, for instance, will not be dissolved

by *Aqua fortis*, but will by *Aqua Regis*; whereas Silver is not soluble by the latter of these Menstruums, but is by the former. And this relative Affection, on whose account a Body comes to be corrodible by a *Menstruum*, seems to consist chiefly in *three* things, which all of them depend upon Mechanical Principles.

Of these Qualifications the *first* is, that the Body to be corroded be furnish'd with Pores of such a bigness and figure, that the Corpuscles of the Solvent may enter them, and yet not be much agitated in them without giving brisk knocks or shakes to the solid parts that make up the walls, if I may so call them, of the Pores. And 'tis for want of this condition, that Glass is penetrated in a multitude of places, but not dissipated or dissolv'd by the incident beams of Light, which permeate its Pores without any considerable resistance; and though the Pores and Commissures of a Body were less

mi-

minute, and capable of letting in some grosser Corpuscles, yet if these were, for want of solidity or rigidness, too flexible, or were of a figure incongruous to that of the Pores they should enter, the Dissolution would not insue; as it happens when pure Spirit of Wine is in the cold put upon Salt of Tartar, or when *Aqua fortis* is put upon powder of Sulphur.

The *second* Qualification of a Corrodible Body is, that its consistent Corpuscles be of such a Bulk and Solidity, as does not render them uncapable of being disjoyn'd by the action of the insinuating corpuscles of the Menstruum. Agreeable to this and the former Observation is the practice of Chymists, who oftentimes, when they would have a Body to be wrought on by a Menstruum otherwise too weak for it in its crude estate, dispose it to receive the action of the Menstruum by previously opening it, (as they speak) that is, by enlarging the Pores, ma-

king a comminution of the Corpuscles, or weakening their Cohesion. And we see, that divers Bodies are brought by fit preparations to be resoluble in Liquors that would not work on them before. Thus, as was lately noted, Lime-stone by Calcination becomes (in part) dissoluble in water; and some Metalline Calces will be so wrought on by Solvents, as they would not be by the same Agents, if the preparation of the Metalline or other Body had not given them a new Disposition. Thus, though crude Tartar, especially in lumps, is very slowly and difficultly dissoluble in cold water, yet when 'tis burnt it may be presently dissolved in that Liquor; and thus, though the Filings and the Calx of Silver will not be at all dissolv'd by common water or Spirit of Wine; yet if by the interposition of the Saline Particles of *Aqua Fortis*, the Lunar Corpuscles be so disjoyn'd, and suffer such a comminution as they do in Crystals of Lune, the Metal thus pre-

prepared and brought with its Saline Additament into a new Texture will easily enough dissolve, not onely in water, but, as I have tried, in well rectified Spirit of Wine. And the like Solubility I have found in the Crystals of Lead made with Spirit of Verdigrease, or good distill'd Vinegar, and in those of Copper made with *Aqua Fortis*.

The *last* Disposition to Corrosibility consists in such a cohesion of the parts, whereof a Body is made up, as is not too strict to be superable by the action of the *Menstruum*. This Condition, though of kin to the former, is yet somewhat differing from it, since a body may consist of parts either bulky or solid, which yet may touch one another in such small portions of their Surfaces, as to be much more easily dissociable than the minute or less solid parts of another Body, whose contact is more full and close, and so their Cohesion more strict.

By what has been ſaid it may ſeem probable, that, as I formerly intimated, the Corroſibility of Bodies is but a Mechanical Relation, reſulting from the Mechanical Affections and Contexture of its parts, as they intercept Pores of ſuch ſizes and figures as make them congruous to thoſe of the Corpuſcles of the *Menſtruum*, that are to pierce between them, and disjoyn them.

That the Quality, that diſpoſes the body it affects to be diſſolv'd by Corroſive and other Menſtruums, does (as hath been declared) in many caſes depend upon the Mechanical Texture and Affections of the body in reference to the Menſtruum that is to work upon it, may be made very probable by what we are in due place to deliver concerning the Pores of Bodies and Figures of Corpuſcles. But yet in compliance with the deſign of theſe Notes, and agreeably to my cuſtom on other Subjects, I ſhall ſubjoyn a few Experiments on this occaſion alſo.

EX-

EXPER. I.

IF we put highly rectified Spirit of Wine upon crude Sulphur, or even Flowers of Sulphur, the Liquor will lie quietly thereon, especially in the cold, for many hours and days without making any visible Solution of it; and if such exactly dephlegmed Spirit were put on very dry Salt of Tartar, the Salt would lie in an undissolved powder at the bottom: and yet, if before any Liquor be employed, the Sulphur be gently melted, and then the Alkali of Tartar be by degrees put to it, and incorporated with it; as there will result a new Texture discoverable to the eye by the new colour of the Composition, so there will emerge a disposition that was not before in either of the Ingredients, to be dissolved by Spirit of Wine; insomuch, that though the mixture be kept till it be quite cold,

er long after too, provided it be carefully ſecur'd from the acceſs of the air, the Spirit of Wine being put to it, and ſhaken with it, will, if you have gone to work aright, acquire a yellow Tincture in a minute of an hour; and perhaps in leſs than half a quarter of an hour a red one, being richly impregnated with ſulphureous Particles diſcoverable by the Smell, Taſte, and divers Operations.

EXPER. II.

'TIs known to ſeveral Chymiſts, that Spirit of Salt does not diſſolve crude Mercury in the cold; and I remember, I kept them for a conſiderable time in no contemptible heat without finding any Solution following. But I ſuppoſe, many of them will be gratified by an Experiment once mention'd to me by an Ingenious German Gentleman, namely, That if Mercury be

be precipitated *per se*, that is, reduc'd to a red powder without additament, by the meer operation of the fire, the Texture will be so chang'd, that the above-mention'd Spirit will readily dissolve it; for I found it upon Trial to do so; nay, sometimes so readily, that I scarce remember that I ever saw any *Menstruum* so nimbly dissolve any Metalline body whatsoever.]

EXPER. III.

THe former Experiment is the more remarkable, because, that though Oyl of Vitriol will in a good heat corrode Quicksilver, (as we have already related in the first Section,) yet I remember I kept a Precipitate *per se* for divers hours in a considerable degree of Heat, without finding it to be dissolved or corroded by the Menstruum. And yet having, for trials sake, put another parcel of the same Mercurial pow-

der

der into some *Aqua fortis*, or Spirit of Nitre, there insued a speedy Dissolution even in the cold.

And that this Disposition to be dissolved by Spirit of Salt, that Mercury acquires by being turned into Precipitate *per se*, that is, by being calcin'd, is not meerly the effect of the operation of the fire upon it, but of some change of Texture produced by that Operation; may be probably argued from hence, that, whereas Spirit of Salt is a very proper *Menstruum*, as I have often tried, for the dissolving of Iron or Steel; yet, when that Metal is reduced by the action of the fire (especially if a kind of Vitrification, and an irroration with distill'd Vinegar have preceded) to *Crocus Martis*, though it be thereby brought to a very fine powder, yet I found not, that, as Spirit of Salt will readily and with heat and noise dissolve Filings of *Mars*, so it would have the same or any thing near such an Operation upon the *Crocus*: but

but rather, after a good while, it would leave in the bottom of the Glass a considerable, if not the greatest, part of it scarce, if at all, sensibly alter'd. And the Menstruum seem'd rather to have extracted a Tincture, than made an ordinary Solution; since the colour of it was a high yellow or reddish, whereas *Mars*, dissolved in Spirit of Salt, affords a green Solution. Whether by repeated Operations with fresh Menstruum further Dissolutions might in time be made, I had not occasion to try, and it may suffice for our present purpose, that *Mars* by the operation of the fire did evidently acquire, not, as Mercury had done, a manifest facility, but on the contrary, a great indisposition to be dissolved by Spirit of Salt.

To second this Experiment, we vary'd it, by employing, instead of Spirit of Salt, strong Oyl of Vitriol, which being pour'd on a little *Crocus Martis* made *per se*, did not, as that *Menstruum* is wont to do upon

on Filings of crude *Mars*, readily and manifestly fall upon the powder with froth and noise, but (on the contrary) rested for divers hours calmly upon it, without so much as producing with it any sensible warmth.

EXPER. IV.

IT agrees very well with our Doctrine about the dependance of the Corrosibility of Bodies upon their Texture, that from divers Bodies, whilst they are in conjunction with others, there result masses, and those homogeneous as to sense, that are easily dissoluble in Liquors, in which a great part of the matter, if it were separated from the rest, would not be at all dissolved. Thus we see, that common Vitriol is easily dissolved in meer water; whereas if it be skilfully calcin'd, it will yield sometimes near half its first weight of insipid Colcothar, which not

not onely is not soluble in water, but which neither *Aqua Fortis* nor *Aqua Regis*, though sometimes they will colour themselves upon it, are able (as far as I have tried) to make Solutions of. We see likewise, that simple water will, being boil'd for a competent time with Harts-horn, dissolve it and make a Jelly of it: And yet, when we have taken Harts-horn throughly calcin'd to whiteness, not onely we found that common water was no longer a fit Solvent for it, but we observed, that when we put Oyl of Vitriol it self upon it, a good part of the white powder was even by that Corrosive Menstruum left undissolved.

EX-

EXPER. V.

IN the *Fifteenth* of the foregoing Experiments I refer to a way of making the Flower or Powder of common Sulphur become *easily dissoluble*, which otherwise 'tis far from being, in highly rectified Spirit of Wine. Wherefore I shall now adde, that 'tis quickly perform'd by gently melting the Sulphur, and incorporating with it by degrees an equal or a greater weight of finely powder'd Salt of Tartar, or of fixt Nitre. For if the mixture be put warm into a Mortar that is so too; and as soon as 'tis reduc'd to powder, be put into a Glass, and well shaken with pure Spirit of Wine, it will, (as perhaps I may have elsewhere observed,) in a few minutes acquire a yellow colour, which afterwards will grow deeper, and manifest it self by the smell and effects to be a real Solution of Sulphur; and

and yet this Solubleness in Spirit of Wine seems procur'd by the change of Texture, resulting from the Commixtion of meer Salt of Tartar, which Chymists know, to their trouble, to be it self a body almost as difficult as Sulphur to be dissolved in phlegmless Spirit of Wine, unless the Constitution of it be first alter'd by some convenient additament. Which last words I adde, because, though Spirit of Verdigrease be a Menstruum that uses to come off in Distillation much more intirely than other acid Menstruums from the bodies it has dissolved; yet it will serve well for an additament to open (as the Chymists speak) the body of the Salt of Tartar. For this purpose I employ Spirit of Verdigrease, not made first with Spirit of Vinegar, and then of Wine, after the long and laborious way prescribed by *Basilius* and *Zwelfer*, but easily and expeditiously by a simple Distillation of crude Verdigrease of the better sort. For when you have with

with this Liquor (being, if there be need, once rectified) diſſolv'd as much good Salt of Tartar, as 'twill take up in the cold, if you draw off the Menſtruum *ad ſiccitatem*, the remaining dry Salt will be manifeſtly alter'd in Texture even to the eye, and will readily enough in high rectified Spirit of Wine afford a Solution, which I have found conſiderable in order to divers uſes that concern not our preſent Diſcourſe.

EXPER. VI.

TO the Conſideration of the Followers of *Helmont* I ſhall recommend an Experiment of that famous Chymiſt's, which ſeems to ſute exceeding well with the Doctrine propos'd in this Section. For he tells us, that, if by a ſubtle Menſtruum to which he aſcribes that power. Quickſilver be deveſted (or depriv'd) of its external Sulphur, as he terms it, all the reſt of the fluid Metal,

Metal, which he wittily enough stiles, the Kernel of Mercury, will be no longer corrosible by it. So that upon this Supposition, though common Quicksilver be observ'd to be so obnoxious to *Aqua Fortis*, that the same quantity of that Liquor will dissolve more of it, than of any other Metal; yet, if by the deprivation of some portion of it the *latent Texture* of the Metal be alter'd, though not (that I remember) the *visible appearance* of it; the Body that was before so easily dissolved by *Aqua Fortis*, ceases to be at all dissoluble by it.

EXPER. VII.

AS for those Chymists of differing Sects, that agree in giving credit to the strange things that are affirm'd of the Operations of the *Alkahest*, we may in favour of our Doctrine urge them with what is deliver'd by *Helmont*, where he asserts,

ſerts, that all ſolid Bodies, as Stones, Minerals, and Metals themſelves, by having this Liquor duly abſtracted or diſtill'd off from them, may be changed into Salt, equiponderant to the reſpective bodies whereon the Menſtruum was put. So that ſuppoſing the *Alkaheſt* to be totally abſtracted, (as it ſeems very probable to be, ſince the weight of the body whence 'twas drawn off is not alter'd;) what other change than of Texture can be reaſonably imagin'd to have been made in the tranſmuted bodies? and yet divers of them, as Flints, Rubies, Saphyrs, Gold, Silver, &c. that were inſoluble before, ſome of them in any known Menſtruums, and others in any but Corroſive Liquors, come to be capable of being diſſolv'd in common water.

EX

EXPER. VIII.

'Tis a remarkable *Phænomenon*, that suits very well with our opinion about the interest of Mechanical Principles in the Corrosive Power of Menstruums, and the Corrosibility of bodies, that we produc'd by the following Experiment: This we purposely made to shew, after how differing manners the same body may be dissolv'd by two Menstruums, whose minute parts are very differingly constituted and agitated. For whereas 'tis known, that if we put large grains of Sea-salt into common water, they will be dissolved therein calmly and silently without any appearance of conflict; If we put such grains of Salt into good Oyl of Vitriol, that Liquor will fall furiously upon them, and produce for a good while a hissing noise with fumes, and a great store of bubbles, as if a potent Menstru-

um were corroding ſome ſtubborn metal or mineral. And this Experiment I the rather mention, becauſe it may be of uſe to us on divers other occaſions. For elſe 'tis not the onely, though it be the remarkableſt, that I made to the ſame purpoſe.

EXPER. IX.

FOr, whereas *Aqua Fortis* or *Aqua Regis*, being pour'd upon Filings of Copper, will work upon them with much noiſe and ebullition, I have tried, that good Spirit of Sal Armoniac or Urine, being put upon the like Filings, and left there without ſtopping the Glaſs, will quickly begin to work on them, and quietly diſſolve them almoſt as water diſſolves Sugar. To which may be added, that even with Oyl of Turpentine I have, though but ſlowly, diſſolved crude Copper; and the Experiment ſeemed to favour our Conjecture the more, becauſe having tried it ſeveral times, it appear'd,

pear'd, that common unrectified Oyl would perform the Solution much quicker than that which was purified and subtiliz'd by rectification; which though more subtle and penetrant, yet was, it seems, on that account less fit to dissolve the Metal, than the grosser Oyl whose particles might be more solid or more advantageously shap'd, or on some other Mechanical account better qualified for the purpose.

EXPER. X.

TAke good Silver, and, having dissolv'd it in *Aqua Fortis*, precipitate it with a sufficient quantity of good Spirit of Salt; then having wash'd the Calx, which will be very white, with common water, and dried it well, melt it with a moderate fire into a fusible Mass, which will be very much of the nature of what Chymists call *Cornu Lunæ*, and which they make by precipitating dissolv'd

Silver with a bare Solution of common Salt made in common water. And whereas both Spirit of Salt and Silver diſſolv'd in *Aqua Fortis* will each of them apart readily diſſolve in ſimple water, our *Luna Cornea* not onely will not do ſo, but is ſo indiſpos'd to Diſſolution, that I remember I have kept it in Digeſtion, ſome in *Aqua fortis*, and ſome in *Aqua Regia*, and that for a good while, and in no very faint degree of heat, without being able to diſſolve it like a Metal, the Menſtruums having indeed ting'd themſelves upon it, but left the Compoſition undiſſolv'd at the bottom.

With this Inſtance (of which ſort more might be afforded by Chymical Precipitations) I ſhall conclude what I deſign'd to offer at preſent about the *Corroſibility* of Bodies, as it may be conſider'd in a more general way. For as to the Diſpoſition that Particular Bodies have of being diſſolved in, or of reſiſting, Determinate Liquors, it were much eaſier

easier for me to enlarge upon that Subject, than it was to provide the Instances above recited. And these are not so few, but that 'tis hop'd they may suffice to make it probable, that in the Relation betwixt a Solvent and the Body it is to work upon, that which depends upon the Mechanical affections of one or both, is much to be consider'd, and has a great interest in the operations of one of the bodies upon the other.

FINIS.

OF THE

MECHANICAL CAUSES OF CHYMICAL PRECIPITATION.

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THough I ſhall not deny, that, in Grammatical ſtrictneſs, Precipitation *ſhould be reckoned among Chymical Operations, not Qualities, yet I did not much ſcruple to inſert the following Diſcourſe among the Notes about Particular Qualities, becauſe many, if not moſt, of the* Phænomena, *mentioned in the enſuing Eſſay, may be conſidered as depending, ſome of them, upon a power, that certain bodies have to cauſe Precipitation, and ſome upon ſuch a Diſpoſition to be ſtruck down by others, as may, if men pleaſe, be called* Precipitability. *And ſo theſe differing Affections may with (at leaſt) tolerable Congruity be referred to thoſe that we have elſewhere ſtiled* Chymical Qualities.

But though I hope, I may in theſe few Lines have ſaid enough concerning the name given to theſe Attributes, yet perhaps it will be found in time, that the things themſelves may deſerve a larger Diſcourſe than my little leaſure would allow them. For that is not a cauſeleſs Intimation of the Importance of the ſubject, wherewith I conclude the following Tract, ſince beſides that many more Inſtances might have been particularly referred to the Heads treated of in the Inſuing Eſſay, there are improper kinds of Precipitation (beſides thoſe mentioned in the former part of the Diſcourſe) to which one may not incongruouſly refer divers of the Phænomena *of Nature, as well in the greater as in the leſſer world, whereof either no Cauſes at all, or but improper ones are wont to be given. And beſides the ſimple Spirits and Salts uſually employed by Chymiſts, there are many compounded and decompounded bodies not only factitious but natural, (and ſome ſuch as one would ſcarce ſuſpect) that may in congruous ſubjects produce*

ſuch

ſuch Precipitations, as I ſpeak of. And the Phænomena and Conſequents of ſuch operations may in divers caſes prove conducive both to the Diſcovery of Phyſical Cauſes, and the Production of uſeful effects; though the particularizing of ſuch Phænomena do rather belong to a Hiſtory *of* Precipitations, *than to ſuch a Diſcourſe as that which follows, wherein I propoſed not ſo much to deliver the latent Myſteries, as to inveſtigate the* Mechanical Cauſes *of Precipitation.*

OF THE MECHANICAL CAUSES OF CHYMICAL PRECIPITATION.

CHAP. I.

BY Precipitation is here meant ſuch an agitation or motion of a heterogeneous liquor, as in no long time makes the parts of it ſubſide, and that uſually in the form of a powder or other conſiſtent body.

As, on many occasions, Chymists call the substance that is made to fall to the bottom of the liquor, the *Precipitate*; so for brevity sake we shall call the body that is put into the liquor to procure that subsiding, the *Precipitant*; as also that which is to be struck down, the *Precipitable substance or matter*, and the liquor wherein it swims before the separation, the *Menstruum* or *Solvent*.

When a hasty fall of a heterogeneous body is procured by a *Precipitant*, the Operation is called *Precipitation* in the proper or strict sense: But when the separation is made without any such addition, or the substance, separated from the fluid part of the liquor, instead of subsiding emerges, then the word is used in a more comprehensive, but less proper, acceptation.

As for the Causes of Precipitation the very name it self in its Chymical sense having been scarce heard of in the Peripatetic Schools, it is not to be expected, that they should have given us

an account of the Reasons of the thing. And 'tis like, that those few *Aristotelians*, that have, by their converse with the laboratories or writings of Chymists, taken notice of this Operation, would, according to their custom on such occasions, have recourse for the explication of it to some secret sympathy or antipathy between the bodies whose action and reaction intervenes in this Operation.

But if this be the way proposed, of accounting for it, I shall quickly have occasion to say somewhat to it in considering the ways proposed by the Chymists, who were wont to refer Precipitation, *either*, as is most usual, to a sympathy betwixt the *Precipitating* body and the *Menstruum* which makes the Solvent run to the embraces of the *Precipitant*, and so let fall the particles of the body sustained before; *or* (with others) to a great antipathy or contrariety between the acid salt of the *Menstruum* and the fixed salt of the Oil, or solution of cal-

calcined Tartar, which is the most general and usual *Precipitant* they imploy.

But I see not, how either of these causes will either reach to all the *Phænomena* that have been exhibited, or give a true account even of some of those, to which it seems applicable. For first, in Precipitations, wherein what they call a *sympathy* between the liquors, is supposed to produce the effect, this admired sympathy does not (in my apprehension) evince such a mysterious occult Quality as is presumed, but rather consists in a greater congruity as to bigness, shape, motion and pores of the minute parts between the *Menstruum* and the *Precipitant*, than between the same Solvent and the body it kept before dissolved. And though this sympathy rightly explained may be allowed to have an interest in some such Precipitations as let fall the dissolved body in its pristine nature and form, and only reduced into minute powder; yet I find not, that in the generality

rality of Precipitations this Doctrine will hold; For in some that we have made of Gold and Silver in proper Menstruums, after the subsiding matter had been well washed and dried, several Precipitates of Gold made, some with oil of Tartar, which abounds with a fixed salt, and is the usual Precipitant, and some with an Urinous Spirit, which works by Vertue of a salt highly fugitive or Volatile, I found the powder to exceed the weight of the Gold and Silver I had put to dissolve; and the Eye it self sufficiently discovers such Precipitates not to be meer metalline powders, but Compositions, whose consisting, not (as hath been by some body suspected) of the combined Salts alone, but of the metalline parts also, may be strongly concluded not only from the ponderousness of divers of them in reference to their bulk, but also manifestly from the reduction of true malleable metals from several of them.

CHAP.

CHAP. II.

THE other *Chymical* way of explicating Precipitations may, in a right ſence, be made uſe of by a Naturaliſt on ſome particular occaſions. But I think it much too narrow and defective, as 'tis in a general way propoſed, to be fit to be acquieſced in. For firſt 'tis plain, that 'tis not only Salt of Tartar and other fixed Alcalies that precipitate moſt bodies that are diſſolved in acid Menſtruums; as in making of *Aurum fulminans*, oil of *Tartar* precipitates the Gold out of *Aqua Regis*: But *acid* liquors themſelves do on many occaſions no leſs powerfully precipitate metals and other bodies out of one another. Thus ſpirit of Salt, (as I have often tried) precipitates Silver out of *Aqua fortis*: The corroſive Spirit of Nitre copiouſly precipitates that white powder whereof they make *Bezoardicum Minerale*: Spirit or oil

oil of Sulphur made by a glass-bell precipitates Corals, Pearls, *&c.* dissolved in Spirit of Vinegar, as is known to many Chymists, who now use this *Oleum Sulphuris per Campanam*, to make the Magistery of Pearls, &c. for which vulgar Chymists imploy *Oleum Tartari per deliquium.*

I have sometimes made a *Menstruum*, wherein though there were both Acid and Alcalizate Salts; yet I did not find, that either acid Spirits or oil of Tartar, or even Spirit of Urine would precipitate the dissolved substances.

And I have observed, *both* that Salts of a contrary nature will precipitate bodies out of the same Menstruum, as not only Salt of Tartar, but Sea-salt being dissolved, will precipitate each other, and each of them apart will precipitate Silver out of *Aqua fortis*; *and* that even, where there is a confessed contrariety betwixt two liquors, it may be so ordered, that neither of them shall precipitate what

is dissolved by the other; of which I shall have occasion to give ere long a remarkable instance.

But it will best appear, that the abovementioned Theories of the Peripateticks and Chymists are at least insufficient to solve the *Phænomena* (many of which were probably not known to most of them, and perhaps not weigh'd by any,) if we proceed to observe the *Mechanical* ways, by which Precipitations may be accounted for; whereof I shall at present propose some Number, and say somewhat of each of them apart; not that I think all of them to be equally important and comprehensive, or that I absolutely deny, that any one of them may be reduced to some of the other; but that I think, it may better elucidate the subject, to treat of them severally, when I shall have premised, that I would not thence infer, that though, for the most part, Nature does principally effect Precipitations by one or other of these ways, yet in divers cases she may

may not imploy two or more of them about performing the operation.

To precipitate the Corpuſcles of a metal out of a Menſtruum, wherein being once throughly diſſolved it would of it ſelf continue in that ſtate, the two general ways that the nature of the thing ſeems to ſuggeſt to him that conſiders it, are, *either* to add to the weight or bulk of the diſſolved Corpuſcles, and thereby render them unfit to accompany the particles of the Menſtruum in their motions; *or* to weaken the ſuſtaining power of the Menſtruum, and thereby diſable it to keep the metalline particles ſwimming any longer: which falling of the deſerted parts of the metal or other bodie, does oftentimes the more eaſily inſue, becauſe in many caſes, when the ſuſtaining particles of the Menſtruum come to be too much weakned, that proves an occaſion to the metalline Corpuſcles, diſturbed in the former motion that kept them ſeparate, to make occurſions and coalitions among themſelves,

ſelves, and their fall becomes the effect, though not equally ſo, of both ways of Precipitation; as on the other ſide, there are ſeveral occaſions on which the ſame Precipitant, that brings the ſwimming particles of the metal to ſtick to one another, does likewiſe, by mortifying or diſabling the ſaline Spirits or other parts of the ſolvent, weaken the ſuſtaining power of that liquor.

CHAP. III.

TO deſcend now to the diſtinct Conſiderations about theſe two ways: The firſt of the moſt genera Cauſes of Precipitation is ſuch a Cohæſion procured by the Precipitant in the ſolution, as makes the compounded corpuſcles, or at leaſt the aſſociated particles of the diſſolved body, too heavy to be ſuſtained, or too bulky to be kept in a ſtate of fluidity by the liquor.

That

That in many Precipitations there is made a coalition betwixt the ſmall parts of the Precipitant and thoſe of the diſſolved metal, or other body, and frequently alſo with the ſaline ſpirits of the Menſtruum, may be eaſily ſhewn by the weight of the Precipitate, which though carefully waſhed and dryed, often ſurpaſſes, and ſometimes very conſiderably, that of your crude metal that was diſſolved; of which we lately gave an inſtance in *Aurum fulminans* and precipitated Silver; & we may yetgive a more conſpicuous one, in that which Chymiſts call *Luna Cornea:* For, if having diſſolved Silver in good *Aqua fortis*, you Precipitate it with the ſolution of Sea-ſalt in fair water, and from the very white Precipitate waſh the looſe adhering ſalts, the remaining powder, being dryed and ſlowly melted, will look much leſs like a metalline body than like a piece of horn, whence alſo it takes its name; ſo conſiderable is

the additament of the saline to the metalline particles.

And that part of such additaments is, retained, may not only be found by weighing, but in divers cases may be argued from what is obvious to the Eye: as if you dissolve Mercury in *Aqua fortis*, and into the philtrated solution drop spirit of Salt, or salt-water, or an urinous spirit, as of Sal Armoniac, you will have a very white Precipitate; but if instead of any of these, you drop-in deliquated salt of Tartar, your Precipitate will be of a brick or orange colour. From which experiment and some others I would gladly take a rise to perswade Chymists and Physitians, that 'tis not so indifferent, as those seem to think who look on Precipitation but as a kind of Comminution, by what means the precipitation is performed. For by reason of the strict adhesion of divers saline particles of the precipitant and the solvent, the precipitated body, notwithstanding all the wonted ablutions

ons, may have its qualities much diverſified by thoſe of the particles of the liquors, when theſe are fitted to ſtick very faſt to it. Which laſt words I add, becauſe, though that ſometimes happens, yet it does not always, there being a greater difference than every body takes notice of between Precipitations; as you will be induced to think, if you precipitate the ſolution of Silver with Copper, with ſpirit of *Sal Armoniac*, with ſalt water, with oil of Tartar, with quick-ſilver, with crude Tartar and with Zink. And in the lately propoſed Example, you will think it probable, that 'tis not all one, whether to diſſolved Mercury or Silver, you imploy the ſubtile diſtilled Spirits of Salt, or the groſs body, whether in a dry form, or barely diſſolved in common water. And thus much of the Conduciveneſs of *weight* to the ſtriking down the Corpuſcles of a diſſolved Body.

That alſo the *Bulk* of a body may very much contribute to make it

ſink or ſwim in a liquor, appears by obvious inſtances. Thus Salt or Sugar, being put into water either in lumps or even in powder that is but groſs, falls at firſt to the bottom, and lies there, notwithſtanding the Air that may be intercepted between its parts or externally adhere to it. But when by the inſinuating action of the water it is diſſolved into minute particles, theſe are carried up and down with thoſe of the liquor and ſubſide not. The like happens, when a piece of ſilver is caſt into *Aqua fortis*, and in many other caſes.

On the other ſide I have ſeveral times obſerved, that ſome bodies that had long ſwam in a Menſtruum, whilſt their minute parts were kept from convening in it, did afterwards by the coalition of many of thoſe particles into bodies of a viſible bulk coagulate and ſubſide, (though ſometimes, to hinder the evaporation of the Menſtruum, the veſſels were kept ſtopt.) Of this I elſewhere mention divers examples; and

and particularly in urinous and animal ſpirits, well dephlegm'd, I have found, that after all had for a conſiderable time continued in the form of a perfect liquor, and as to ſenſe homogeneous, ſtore of ſolid corpuſcles, convening together, ſetled at the bottom of the glaſſes in the form of ſaline Cryſtals. Having alſo long kept a very red ſolution of Sulphur firſt unlock'd, (as they ſpeak) made with highly rectified ſpirit of urine, I obſerved, that at length the Sulphureous particles, making little concretions between themſelves, totally ſubſided and left the liquor almoſt devoid of tincture. By which you may ſee, that 'twas not impertinent to mention (as I lately did) among the ſubordinate cauſes of Precipitation, the aſſociating of the particles of a diſſolved body with one another. Of which I elſewhere give a notable Example in the ſhining powder that I obtained from Gold diſſolved in a peculiar Menſtruum, without any Precipi-

tant, by the coalition of the metalline particles, to which a tract of time gave opportunity to meet and adhere in a convenient manner.

If in what the Chymists call *Precipitate per se*, the Mercury be indeed brought to lose its fluidity, and become a powder without being compounded with any additional body, (which doubt I elsewhere state and discourse of) it will afford us a notable instance to prove, that the coalitions of particles into clusters of the self same matter will render them unfit for the motion requisite to fluidity. For in this odd precipitation by fire, wherein the same Menstruum is both the Liquor and the Precipitate, being not all made at once, the Corpuscles that first disclose themselves by their redness, are rejected by those of the Mercury that yet remains fluid, as unable to accompany them in the motions that belong to Mercury as such.

CHAP.

CHAP. IV.

BEfore I diſmiſs that way of Precipitating, that depends upon the unwieldineſs which the Precipitant gives to the body it is to ſtrike down, it may not be impertinent, eſpecially in reference to the foregoing part of this Paper, to conſider, that perhaps in divers caſes the Corpuſcles of a diſſolved body may be made unfit to be any longer ſuſtained in the Menſtruum, though the Precipitant adds very little to their bulk, or at leaſt much more to their ſpecific weight than to it. For I have elſewere ſhewn, that in divers ſolutions made of bodys by acid Menſtruums, there are either generated or extricated many ſmall Aerial particles; and it will be eaſily granted, that theſe may be ſmall enough to be detained in the pores of the liquor and be inviſible there, if we conſider, what a multitude of aerial and formerly imperceptible bubbles

is afforded by common water in our Pneumatical Receivers, when the incumbent air that before preſſed the liquor, is pumpt out. And if the Corpuſcles of the diſſolved body have any little Cavities or pores fit to lodge Aerial particles, or have aſperous ſurfaces, between whoſe prominent parts the generated air may conveniently lie; in ſuch caſes, I ſay, theſe Inviſible bubbles may be lookt upon, as making with the ſolid Corpuſcles they adhered to, little aggregates much lighter *in ſpecie* than the Corpuſcles themſelves would be; and conſequently if the Precipitant conſiſt of particles of ſuch a ſize and ſhape as are fit to expel theſe little bubbles, and lodge themſelves in the cavities poſſeſſed by them before, there will be produced new aggregates compoſed of the Corpuſcles of the diſſolved body and the particles of the Precipitant; which aggregates though they do take up very little or perhaps not at all more room (taking that word in a popular ſenſe) than

thoſe,

thoſe, whereof the Aerial bubbles made a part, will yet be Specifically heavier than the former Aggregates were, and may thereby overcome the ſuſtaining power of the Menſtruum.

One thing more may be fit to be taken notice of before we paſs on further, namely, that 'tis upon the ſcore of the Specific gravity of a body, and not barely upon the action of the Precipitant, that an aggregate or a Convention of particles does rather fall to the bottom than riſe to the top. For, though the Agents that procured the Coalition, make the cluſter of particles become of a bulk too unwieldy to continue in the liquor as parts of it; yet if each of them be lighter *in ſpecie* than an equal bulk of the Menſtruum, or if they ſo convene as to intercept a ſufficient number of little bubbles or aerial Corpuſcles between them, and ſo become lighter than as much of the Menſtruum as they take up the room of, they will not be precipitated but

but emerge; as may be seen in the Preparation of those Magisteries of Vegetables, I elsewhere mention; where some deeply colour'd plants being made to tinge plentifully the Lixivium they are boyled in, are afterwards by the addition of Alum made to curdle, as it were, into coloured Concretions, which being (totally or in part) too big to swim as they did before they conven'd, and too light in comparison of the Menstruum to subside, emerge to the top and float there. An easier and neater Example to the same purpose I remember I shewed by dissolving Camphire in highly rectified spirit of Wine, 'till the solution was very strong. For though the Camphire, when put in Lumps into the spirit, sunk to the bottom of it; yet, when good store of water, (a liquor somewhat heavier in *Specie* than Camphire,) was poured upon the solution, the Camphire quickly concreted and returned to its own nature, and within a while emerged to the top of the mingled liquors and floated

floated there. These particulars I was willing to mention here, that I might give an instance or two of those precipitations, that I formerly spake of as improperly so called. And here I must not decline taking notice of a Phænomenon, that sometimes occurs in Precipitations, and at first sight may seem contrary to our Doctrine about them. For now and then it happens, that after some drops of the Precipitant have begun a Precipitation at the top or bottom of the Solvent, one shakes the vessel, that the Precipitant may be the sooner diffused through the other liquor, but then they are quickly surprized to find, that instead of hastning the compleat Precipitation, the matter already precipitated disappears, and the solvent returns to be clear, or, as to sense, as uniform, as it was before the Precipitant was put into it. But this *Phænomenon* does not at all cross our Theory. For, when this happens, though that part of the Solvent, to which the Precipitant reaches, is disabled

disabled for Reasons mentioned in this Discourse to support the dissolved body, yet this quantity of the Precipitant is but small in proportion to the whole bulk of the solvent. And therefore, when the agitation of the vessel disperses the clusters of loosly concreted particles through the whole liquor, (which is seldom so exactly proportioned to the body it was to work on, as to be but just strong enough to dissolve it) that greater part of the Liquor, to which before the shaking of the vessel the Precipitant did not reach, may well be lookt upon as a fresh Menstruum, which is able to mortifie or overpower the small quantity of the Precipitant that is mingled with it, and so to destroy its late operation on the body dissolved, by which means the solution returns, as to sense, to its former state. Which may be illustrated by a not unpleasant Experiment, I remember I have long since made by precipitating a brick-coloured powder out of a strong solution of Sublimate

mate made in fair water. For this subsiding matter, being laid to dry in the Philter, by which 'twas separated from the water, would retain a deep but somewhat dirty colour; and if then, putting it into the bottom of a wine glass, I poured upon it, either clear oil of Vitriol, or some other strong acid Menstruum, the Alcalizat particles being disabled and swallowed up by some of the acid ones of the Menstruum, the other acid ones would so readily dissolve the residue of the powder, that in a trice the colour of it would disappear and the whole mixture be reduced into a clear Liquor, without any sediment at the bottom.

Thus much may suffice at present about the first general way of Precipitating Bodies out of the Liquors they swam in.

CHAP.

CHAP. V.

THE other of the two principal ways, by which Precipitations may be effected, is the disabling of the Solvent to sustain the dissolved body.

There may be many instances, wherein this second way of effecting Precipitations may be associated by Nature with the first way formerly proposed; but notwithstanding the cases, wherein Nature may (as I formerly noted) imploy both the ways therein, yet in most cases they sufficiently differ, in regard that in the former way the subsiding of the dissolved body is chiefly, if not only, caused by the additional weight as well as action of the external Precipitant; whereas in most of the instances of the later way, the effect is produced *either* without salt of Tartar, or any such Precipitant, *or* by some other quality of the Precipitant

tant *more than* by its weight, or at leaſt *beſides* the weight it adds: Though I forget not, that I lately gave an example of a ſhining powder of Gold, that fell to the bottom of a Menſtruum without the help of an External Precipitant: But that was done ſo ſlowly, that it may be diſputed, whether it were a true Precipitation; and I alledged it not as ſuch, but to ſhew, that the increaſed bulk of Particles may make them unfit to ſwim in Menſtruums, wherein they ſwam whilſt they were more minute. And the like anſwer may be accommodated to the Precipitate *per ſe* newly mentioned.

This premiſed, I proceed now to obſerve, that the general way, I laſt propoſed, contains in it ſeveral ſubordinate wayes, that are more particular; of which I ſhall now mention the chief that occur to me, and though but briefly, illuſtrate each of them by examples. And firſt a Precipitation may be made, if the ſaline or other diſſolving particles of the Menſtru-

Menstruum are mortified or rendred unfit for their former function, by particles of a Precipitant that are of a contrary nature.

Thus Gold and some other minerals, being dissolved in *Aqua Regis*, will be precipitated with spirit of urine and other such liquors abounding with volatile and salino-sulphureous Corpuscles, upon whose account it is that they act; whence these salts themselves, though cast into a Menstruum in a dry form, will serve to make the like Precipitations. And I the rather on this occasion mention Urinous spirits than Salt of Tartar, because those volatile particles add much less of weight to the little Concretions, which compose the Precipitated powder.

Upon instances of this kind, many of the modern Chymists have built that Antipathy betwixt the Salts of the solvent and those of the Menstruum, to which they ascribe almost all Precipitations. But against this I have represented something already, and

and ſhall partly now, and partly in the ſequel of this diſcourſe add ſome farther reaſons of my not being ſatisfied with this Doctrine. For, beſides that 'tis inſufficient to reach many of the *Phænomena* of Precipitations, (as will ere long be ſhown,) and beſides that 'tis not eaſie to make out, that there is any real antipathy betwixt inanimate bodies; I conſider, 1. That ſome of thoſe Menſtruums, to which this Antipathy is attributed, do after a ſhort commotion (whereby they are diſpoſed to make convenient occurſions and coalitions) amicably unite into concretions participating of both the Ingredients; as I have ſomewhere ſhewn by an Example purpoſely devis'd to make this out; to do which I dropped a clear ſolution of fixed Nitre, inſtead of the uſual one of common ſalt, upon a ſolution of ſilver, in *Aqua-fortis*: For the ſaline particles of the Solvent and thoſe of the Precipitant, will, as I have elſewhere reci-

recited, for the most part friendly unite into such Crystals of Nitre for the main, as they were obtained from: And though this notion of the Chymists, if well explained, be applicable to far more instances than the proposers of it seemed to have thought on, and may be made good use of in Practice; yet I take it to be such as is not true Universally, and, where it is true, ought to be explicated according to Mechanical Principles. For, if the particles of the Menstruum and those of the Precipitant be so framed, that upon the action of the one upon the other, there will be produced Corpuscles too big and unwieldy to continue in the state of fludity, there will insue a Precipitation: But if the constitution of the corpuscles of the Precipitating and of the Dissolved body be such, that the Precipitant also it self is fit to be a Menstruum to dissolve that body in; then, though there be an union of the Salts of the Precipitant

tant and the metal (or other *Solutum*) and perhaps of the ſolvent too, yet a Precipitation will not neceſſarily follow, though the ſaline particles of the two liquors ſeemed, by the heat and ebullition excited between them upon their meeting, to exerciſe a great and mutual antipathy. To ſatisfie ſome Ingenious men about this particular, I diſſolved *Zink* or *Speltar* in a certain urinous ſpirit; (for, there are more than one that may ſerve the turn;) and then put to it a convenient quantity of a proper acid ſpirit; but though there would be a manifeſt conflict thereby occaſioned betwixt the two liquors; yet the ſpeltar remained diſſolved in the mixture. And I remember, that for the ſame purpoſe I deviſed another Experiment, which is ſomewhat more eaſie and more clear. I diſſolved Copper calcined *per ſe*, or even crude, in ſtrong ſpirit of ſalt; (for unleſs it be ſuch, it will not be ſo proper,) and having put to it by degrees a

good quantity of ſpirit of Sal-Armoniac or fermented Urine, though there would be a great commotion with hiſſing and bubbles produced, the Copper would not be precipitated, becauſe this Urinous ſpirit will as well as the Salt, (and much more readily) diſſolve the ſame metal, and it would be kept diſſolved notwithſtanding their operation on one another; the intervening of which, and their action upon the metalline corpuſcles, may be gathered from hence, that the green ſolution, made with ſpirit of ſalt alone, will by the ſupervening urinous ſpirits be changed either into a blewiſh green, or, if the proportion of this ſpirit be very great, into a rich blew almoſt like ultramarine. And from theſe two Experiments we may probably argue, that when the Precipitation of a metal &c. inſues, it is not barely on the account of the ſuppoſed Antipathy betwixt the Salts, but becauſe the cauſes of that ſeeming Antipathy do

do likewiſe upon a Mechanical account diſpoſe the Corpuſcles of the confounded liquors ſo to cohere, as to be too unwieldy for the fluid part.

CHAP. VI.

ANother way, whereby the diſſolving particles of a Menſtruum may be rendred unfit to ſuſtain the diſſolved body, is to preſent them another that they can more eaſily work on.

A notable Experiment of this you have in the common practice of *Refiners*, who, to recover the Silver out of Lace and other ſuch mixtures wherein it *abounds*, uſe to diſſolve it in *Aqua fortis*, and then in the ſolution leave Copper plates for a whole night (or many hours.) But if you have a mind to ſee the Experiment without waiting ſo long, you may

imploy the way, whereby I have often quickly diſpatched it. As ſoon then as I have diſſolved a convenient quantity, which needs not be a great one, of Silver in cleanſed *Aqua fortis*, I add twenty or twenty five times as much of either diſtilled water or rain water; (for though common water will ſometimes do well, yet it ſeldome does ſo well;) and then into the clear ſolution I hang by a ſtring a clean piece of Copper, which will be preſently covered with little ſhining plates almoſt like ſcales of fiſh, which one may eaſily ſhake off and make room for more. And this may illuſtrate what we formerly mentioned about the ſubſiding of metalline corpuſcles, when they convene in liquors, wherein, whilſt they were diſperſed in very minute parts, they ſwam freely. For in this operation the little ſcales of Silver ſeemed to be purely metalline, and there is no ſaline Precipitant, as Salt of Tartar or of Urine, imployed to make them ſubſide.

subside. Upon the same ground, Gold and Silver dissolved in their proper Menstruums may be precipitated with running Mercury; and if a Solution of blew Vitriol (such as the Roman, East-Indian, or other of the like colours) be made in water, a clean plate of Steel or Iron being immersed in it, will presently be overlaid with a very thin case of Copper, which after a while will grow thicker; but does not adhere to the iron so loosely as to be shaken off, as the Precipitated silver newly mentioned may be from the Copper-plates whereto it adheres. And that in these operations the saline particles may really quit the dissolved body, and work upon the Precipitant, may appear by the lately mentioned practice of *Refiners*, where the *Aqua-fortis*, that forsakes the particles of the silver, falls a working upon the copper-plates imployed about the Precipitation, and dissolves so much of them as to acquire the greenish

blew colour of a good ſolution of that metal. And the Copper we can eaſily again without ſalts obtain by Precipitation out of that liquor with iron, and that too, remaining diſſolved in its place, we can precipitate with the taſtleſs powder of another Mineral.

Beſides theſe two ways of weakning the Menſtruum, namely, by mortifying its ſaline particles or ſeducing them to work on other bodies, and to forſake thoſe they firſt diſſolved, there are ſome other ways of weakning the Menſtruum.

A Third way of effecting this, is by leſſening or diſturbing the agitation of the ſolvent. And indeed ſince we find by experience, that ſome liquors when they are heated, will either diſſolve ſome bodies they would not diſſolve at all when they were cold, or diſſolve them more powerfully or copiouſly when hot than cold; 'tis not unreaſonable to ſuppoſe, that what conſiderably leſ-

ſens

ſens that agitation of the parts of the Menſtruum that is neceſſary to the keeping the diſſolved body in the ſtate of fluidity, ſhould occaſion the falling of it again to the bottom. In ſlow operations I could give divers examples of the precipitating power of Cold; there being divers ſolutions and particularly that of Ambergreece, that I had kept fluid all the Summer, which in the Winter would ſubſide. And the like may be ſometimes obſerved in far leſs time in the ſolutions of Brimſtone made in certain oleaginous Menſtruums; and I have now & then had ſome ſolutions, and particularly one of *Benzoin* made in ſpirit of wine, that would ſurprize me with the turbidneſs (which begins the ſtate of Precipitation) it would acquire upon a ſudden change of the weather towards Cold, though it were not in the winter ſeaſon.

Another way of weakening the Menſtruum and ſo cauſing the Precipitation of a body diſſolved in it, is the

the diluting or leſſening the tenacity of it, whether that tenacity proceed from viſcoſity or the competent number and conſtipation of the parts.

Of this we have an inſtance in the Magiſteries (as many Chymiſts are pleaſed to call them) of Jalap, Benzoin, and of divers others, Reſinous and Gummous bodies diſſolved in ſpirit of wine. For by the affuſion of common water, the Menſtruum being too much diluted is not able to keep thoſe particles in the ſtate of fluidity, but muſt ſuffer them to *ſubſide*, (as they uſually do in the form of white powder,) or, (as it may happen ſometimes,) make ſome parts emerge. Examples alſo of this kind are afforded us by the common preparations of *Mercurius Vitæ*. For though in oil of Antimony, made by the Rectification of the butter, the ſaline particles are ſo numerous and keep ſo cloſe to one another, that they are able to ſuſtain the Antimo-

nial

nial Corpuſcles they carried over with them in Diſtillation, and keep them together with themſelves in the form of a liquor; yet when by the copious affuſion of the water, thoſe ſuſtaining particles are ſeparated and removed to a diſtance from each other, the Antimonial Corpuſcles and the Mercurial (if any ſuch there were,) being of a ponderous nature, will eaſily ſubſide into that Emetic powder, which, (when well waſhed) the Chymiſts flatteringly enough call *Mercurius Vitæ*.

But here I muſt interpoſe an advertiſement, which will help to ſhew us, how much Precipitations depend upon the Mechanical contextures of bodies. For, though not only in the newly recited examples, but in divers others, the affuſion of water, by diluting the ſalts and weakening the Menſtruum, makes the metall or other diſſolved body fall precipitately to the bottom; yet if the ſaline particles of the ſolvent, and thoſe

those of the body be fitted for so strict an union, that the Corpuscles resulting from their Coalitions will not so easily be separated by the particles of water, as suffer themselves to be carried up and down with them, whether because of the minuteness of these compounded Corpuscles, or because of some congruity betwixt them and those of the water; they will not be precipitated out of the weakened solution, but still continue a part of it; as I have tryed partly with some solution of Silver and Gold, made in acid Menstruums, but much more satisfactorily in solutions of Copper, made in the urinous spirit of Sal Armoniac. For, though that blew solution were diluted with many thousand times as much distilled water as the dissolved metal weighed; yet its swimming Corpuscles did by their colour manifestly appear to be dispersed through the whole liquor.

CHAP.

CHAP. VII.

BUT, to profecute our former diſcourſe, which we broke off after the mention of *Mercurius Vitæ*, 'twill now be ſeaſonable to add, that we have made divers other Precipitations, by the bare affuſion of water, out of ſolutions, and ſometimes out of diſtilled liquors; which, for brevity ſake, I here omit, that I may haſten to the laſt way I ſhall now ſtay to mention.

Another way then, whereby Precipitations of bodies may be produced by debilitating the Menſtruum they ſwim in, is by leſſening the proportion of the Solvent to the *Solutum*, without any evaporation of the liquor. Theſe laſt words I add, becauſe that, when there is an obſtruction or any other expulſion of the Menſtruum by heat, if it

it be total, 'tis called Exſiccation, as when dry ſalt of Tartar is obtained from the filtrated *Lixivium* of the calcined Tartar; and though the evaporation be not total, yet the effects of it are not wont to be reckoned amongſt Precipitations. And although the way, I am about to propoſe, if it be attentively conſidered, has much affinity with the foregoing, and the *Phænomena* may perhaps in ſome ſort be reduced to them; yet the inſtances that I ſhall name, having not, that I know, been thought of by others, and being ſuch as every one would not deduce from what I have been mentioning, I ſhall add a word of the inducements I had to make the tryals, as well as of the ſucceſs of them.

Conſidering then, that Water will not diſſolve Salts indefinitely, but when it has received its due proportion, 'twill then diſſolve no more, but, if they be put into it, let them fall

fall to the ground and continue undiſſolved; and that if when water is ſatiated, any of the liquor be evaporated or otherwiſe waſted, it will in proportion let fall the ſalt it had already taken up; I concluded, that if I could mingle with water any liquor, with which its particles would more readily aſſociate than with thoſe of Salt, the depriving the ſolution of ſo many of its aqueous particles would be equivalent to the evaporation of as much water or thereabouts, as they, by being united, could compoſe. Wherefore making a *lixivium* of diſtilled water or clean rain-water, and of Salt of Tartar ſo ſtrong, that if a grain more were caſt in it, it would lie undiſſolved at the bottom; I put a quantity of this fiery Lixivium into a ſlender cylindrical veſſel, till it had therein reached ſuch a height as I thought fit; then taking as much as I thought ſufficient of ſtrong ſpirit of wine, that would

would burn every drop away, that ſo it might have no flegm nor water of its own, I poured this upon the ſaline ſolution, and ſhaking the liquors pretty well together to bring them to mix as well as I could, I laid the tube in a quiet place, and afterwards found, as I expected, that there was a pretty quantity of white ſalt of Tartar fallen to the bottom of the veſſel, which ſalt had been meerly forſaken by the aqueous particles that ſuſtained it before, but forſook it to paſs into the ſpirit of wine, wherewith they were more diſpoſed to aſſociate themſelves; which I concluded, becauſe having, before I poured on this laſt named liquor, made a mark on the glaſs to ſhew how far the *lixivium* reached, I found (what I looked for) that after the Precipitation, the *Lixivium*, that remained yet ſtrong enough to continue unmixed with the incumbent ſpirit, had its ſurface not where the mark ſhewed it had been

been before, but a conſiderable diſtance beneath it, the ſpirit of wine having gained in extent what it loſt in ſtrength by receiving ſo many aqueous particles into it. I choſe to make this tryal rather with a *Lixivium* of Salt of Tartar than with oyl of Tartar *per Deliquium*, becauſe in this laſt named liquor the aqueous and ſaline particles are more cloſely combined and therefore more difficult to be ſeparated than I thought they would be in a *Lixivium* haſtily made, though very ſtrong. And though by much agitation I have ſometimes obtained ſome ſalt of Tartar from the abovementioned oil; yet the experiment ſucceeded nothing near ſo well with that liquor as with a *Lixivium*.

I made alſo the like tryal with exceedingly dephlegmed ſpirit of wine, and as ſtrong a Brine as I could make of common ſalt diſſolved without heat in common water; and I thereby obtained no deſpicable proportion of finely figured ſalt, that

was let fall to the bottom. But this experiment, to be ſucceſful, requires greater care in him that makes it, than the former needs.

To confirm, and ſomewhat to vary this way of Precipitation, I ſhall add, that having made a clear ſolution of choice Gum Arabic in common water, and poured upon it a little high rectified ſpirit of wine, on this occaſion there was alſo made, and that in a trice, a copious precipitation of a light and purely white ſubſtance not unpleaſant to behold. And for further Confirmation I diſſolved a full proportion of Myrrhe in fair water, and into the filtrated ſolution, which was tranſparent, but of a high brown colour, I dropt a large proportion (which Circumſtance is not to be omitted) of carefully dephlegm'd ſpirit of wine, which according to expectation made a copious Precipitate of the Gum. And theſe inſtances I the rather ſet down in this place, becauſe they ſeem to ſhow, that

ſimple

ſimple water is a real Menſtruum, which may have its diſſolving and ſuſtaining virtue weakened by the acceſſion of Liquors, that are not doubted to be much ſtronger than it.

By ſpecifying the hitherto mentioned wayes, whereby Precipitations may be Mechanically performed and accounted for, I would by no means be thought to deny, that there may be ſome omitted here, which either others that ſhall conſider the matter with more attention, or I my ſelf, if I ſhall have leiſure to do it, may think on. For I propoſe theſe but as the chief that occurr to my preſent thoughts; and I forbear to add more inſtances to exemplifie them, becauſe I would not injure ſome of my other papers, that have a greater right to thoſe Inſtances. Only this I ſhall note in general, that the Doctrine and Hiſtory of Precipitations, if well delivered, will be a thing of more extent and moment than ſeems hitherto to have been imagined; ſince *not only* ſeveral of

the changes in the blood and other liquors and juices of the humane body may thereby be the better understood; and they prevented, or their ill consequences remedied; *but* in the practical part of Mineralogy divers usefull things may probably be performed by the assistance of such a Doctrine and History. To keep which conjecture from seeming extravagant, I shall only here intimate, that 'tis not alone in bodies that are naturally or permanently liquid, but in those solid and ponderous bodies, that are for a short time made so by the violence of the fire, that many of the things suggested by this Doctrine may have place. For whilst divers of those Bodies are in fusion, they may be treated as liquors; and metalls, and perhaps other heterogeneous bodies may be obtained from them by fit though dry Precipitants, as in some other writings I partly did, and may elsewhere yet further, declare.

FINIS.

Experiments and Notes ABOUT THE MECHANICAL PRODUCTION OF Magnetism.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

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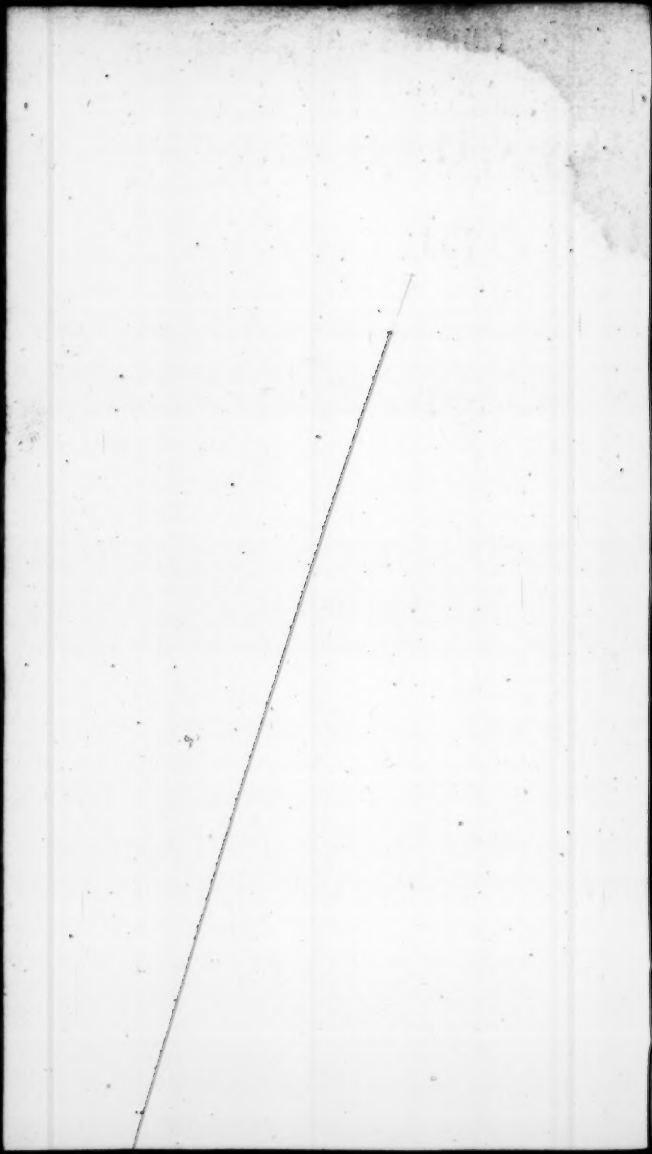

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Concerning the following

NOTES

About OCCULT

QUALITIES.

THE following Papers (about Magnetism *and* Electricity*) would appear with less disadvantage, if the Author's willingness and Promise, that this Tome should be furnished with notes about some* Occult Qualities, *as well as about divers sorts of those that are presumed to be* Manifest, *did not prevail with him to let the ensuing Notes appear without those about the* Pores *of Bodies and* Figures *of Corpuscles, that should have preceded them, and some others that should have*

accompanied them. But the Author choſe rather to venture theſe Papers abroad in the Condition, ſuch as 'tis, they now appear in, than make thoſe already printed about manifeſt *Qualities ſtay longer for Acceſſions, which ſome troubleſome Accidents will not ſuffer him to haſten to the preſs; and without which, he now fears this Tome may ſwell to a more than competent Bulk.*

EXPE-

Experiments and Notes ABOUT THE Mechanical Production OF MAGNETICAL QUALITIES.

THough the vertues of the *Loadſtone* be none of the leaſt famous of *Occult* Qualities, and are perhaps the moſt juſtly admired; yet I ſhall venture to offer ſomething to make it probable, that ſome, even of theſe, may be introduced into bodies by the production of *Mechanical* changes in them.

To make way for what I am to deliver to this purpoſe, it will be ex-

pedient to remove that general and ſettled prejudice, that has kept men from ſo much as thinking of any Mechanical account of Magnetiſms, which is a belief, that theſe Qualities do immediately flow from the *Subſtantial Form* of the Loadſtone, whoſe abſtruſe nature is diſproportionate to our underſtandings. But for my part, I con-

EXPER. I. feſs, I ſee no neceſſity of admitting this ſuppoſition; for I ſee, that a piece of Steel fitly ſhaped and well excited, will, like a Loadſtone, have its determinate Poles, and with them point at the North and South; it will draw other pieces of Iron and Steel to it, and which is more, communicate to them the ſame kind, though not degree, of attractive and directive vertue it had it ſelf, and will poſſeſs theſe faculties not as light and tranſient impreſſions, but as ſuch ſetled and durable Powers that it may retain them for many years, if the Loadſtone, to which it has been duly

duly applied, were vigorous enough: Of which ſort I remember I have ſeen one (and made ſome tryals with it) that yielded an income to the owner, who received money from Navigators and others for ſuffering them to touch their needles, ſwords, knives &c. at his excellent Magnet. Now, in a piece of ſteel or iron thus excited, 'tis plain, that the Magnetic operations may be regularly performed for whole years by a body, to which the form of a Loadſtone does not belong, ſince, as it had its own form before, ſo it retains the ſame ſtill, continuing as malleable, fuſible &c. as an ordinary piece of the ſame metal unexcited: ſo that, if there be introduced a fit diſpoſition into the internal parts of the metal by the action of the Loadſtone, the metal, continuing of the ſame *ſpecies* it was before, will need nothing ſave the continuance of that acquired diſpoſition to be capable of performing Magnetical Operations; and if this diſpoſition or inter-

nal conſtitution of the excited iron be deſtroyed, though the form of the metal be not at all injured, yet the former power of Attraction ſhall be aboliſhed, as appears when an excited iron is made red hot in the fire, and ſuffered to cool again.

EXPER. II.

And here give me leave to take notice of what I have elſewhere related to another purpoſe, namely that a Loadſtone may (as I have more than once tryed) be eaſily deprived by ignition of its Power of ſenſibly attracting Martial bodies, and yet be ſcarce, if at all, viſibly changed, but continue a true Loadſtone in other capacities, which, according to the vulgar Philoſophy ought to depend upon its *Subſtantial Form*, and the Loadſtone thus ſpoiled may, notwithſtanding this Form, have its [illegible] at pleaſure like a piece

EXPER. III.

piece of Iron; as I have elsewhere particularly declared.

And I will confirm what I have been saying with an experiment that you do not perhaps expect; namely, that though it be generally taken for granted (without being contradicted that I know of by any man) that, in a sound Loadstone, that has never been injured by the fire, not only the attractive Power, but the particular Vertue that it has to point constantly, when left to it self, with one of its determinate extreams to one determinate pole, flowes immediately from the substantial or at least essential Form; yet this Form remaining undestroyed by Fire, the Poles may be changed, and that with ease and speed. For among my notes about Magnetical Experiments, whence I borrow some passages of this paper, I find the following Account.

Ex-

EXPER. IV.

TO ſhew that the virtue that a Loadſtone hath by this determinate Pole or Extream to attract, for example, the South-end of a poiſed needle, and with the oppoſite extream or Pole the North-end of the ſame needle, I made among other tryals the following Experiment.

Taking a very ſmall fragment of a Loadſtone, I found, agreeably to my conjecture, that by applying ſometimes one Pole, ſometimes the other, to that pole of (a ſmall but) a very vigorous Loadſtone that was fit for my purpoſe, I could at pleaſure, in a few minutes, change the Poles of the little fragment, as I tryed by its operations upon a needle freely poiſed; though by applying a fragment a pretty deal bigger, (for in it ſelf it appeared very ſmall,) I was not able in far more hours than I employed minutes before, to make any ſenſible change of the Poles.

This

This ſhort Memorial being added to the preceding part of this diſcourſe, will, I hope, ſatisfie you, that how unanimouſly ſo ever men have deduced all magnetick operations from the form of the Loadſtone; yet ſome internal change of pores or ſome other Mechanical alterations or inward diſpoſition, either of the excited Iron or of the Loadſtone it ſelf, may ſuffice to make a body capable or uncapable of exerciſing ſome determinate magnetical operations; which may invite you to caſt a more unprejudiced eye upon thoſe few particulars, I ſhall now ſubjoin to make it probable, that even Magnetical Qualities may be Mechanically produced or altered.

EXPER. V.

I Have often obſerved in the ſhops of Artificers, as Smiths, Turners of metals &c. that, when hardened and well tempered tools are well heated by Attrition, if whileſt

whileſt they are thus warmed you apply them to filings or chips, as they call them, or thin fragments of Steel or Iron, they will take them up, as if the inſtruments were touched with a Loadſtone: but as they will not do ſo, unleſs they be thus excited by rubbing till they be warmed, by which means a greater commotion is made in the inner parts of he Steel ſo neither would they retain ſo vigorous a Magnetiſm as to ſupport the little fragments of Steel that ſtuck to them after they were grown cold again. Which may be confirmed by what, if I much miſremember not, I ſhewed ſome Acquaintances of yours; which was, that, by barely rubbing a conveni-

EXPER. VI. ently ſhaped piece of Steel againſt the floor till it had gained a ſufficient heat, it would whileſt it continued ſo, diſcover a manifeſt, though but faint attractive power, which vaniſhed together with the adventitious Heat.

EX-

EXPER. VII.

WE elsewhere observe, which perhaps you also may have done, that the Iron bars of windows, by having stood very long in an erected posture, may at length grow Magnetical, so that, if you apply the North point of a poised and excited Needle to the bottom of the Bar, it will drive it away, & attract the Southern; and if you raise the magnetick needle to the upper part of the Bar, and apply it as before, this will draw the Northern extream, which the other end of the bar expelled; probably because, as 'tis elsewhere declared, the bar is in tract of time, by the continual action of the Magnetical *effluvia* of the Tarraqueous Globe, turned into a kind of Magnet, whose lower end becomes the North-pole of it, and the other the Southern. Therefore according to the Magnetical Laws, the former must expel the Northern extream

tream of the Needle, and the later draw it.

EXPER. VIII.

I Have found indeed, and I queſtion not but other obſervers may have done ſo too, that, if a bar of Iron, that has not ſtood long in an erected poſture, be but held perpendicular, the forementioned experiment will ſucceed, (probably upon ſuch an account as that I have lately intimated:) But then this virtue, diſplayed by the extreams of the bar of Iron, will not be at all permanent, but ſo tranſient, that, if the bar be but inverted and held again upright, that end which juſt before was the uppermoſt, and drew the north-end of the needle, will now, being lowermoſt, drive it away, which, as was lately obſerved, will not happen to a bar which has been ſome years or other competent time kept in the ſame Poſition. So that, ſince

ſince length of time is requiſite to make the verticity of a bar of Iron ſo durable & conſtant, that the ſame extream will have the ſame virtues in reference to the Magnetical needle, whether you make it the upper end or the lower end of the bar, it ſeems not improbable to me, that by length of time the whole Magnetick virtue of this Iron may be increaſed, and conſequently ſome degree of attraction acquired.

And by this Conſideration I ſhall endeavour to explicate that ſtrange thing, that is reported by ſome Moderns to have happened in *Italy*, where a bar of Iron is affirmed to have been converted into a Loadſtone, whereof a piece was kept among other rarities in the curious *Aldrovandus* his *Muſæum Metallicum*. For conſidering the greatneſs of its Specific Gravity, the malleableneſs and other properties, wherein Iron differs from Loadſtone, I cannot eaſily believe, that, by ſuch a way as is mentioned, a metal ſhould be turned into

into a ſtone. And therefore, having conſulted the book it ſelf, whence this Relation was borrowed, I found the ſtory imperfectly enough delivered: The chiefeſt and cleareſt thing in it being, that at the top of the Church of *Arimini* a great iron-bar, that was placed there to ſupport a Croſs of an hundred pound weight, was at length turned into a Loadſtone. But whether the reality of this tranſmutation was examined, and how it appeared that the fragment of the Loadſtone preſented to *Aldrovandus* was taken from that bar of Iron, I am not fully ſatisfied by that Narrative. Therefore, when I remember the great reſemblance I have ſometimes ſeen in colour, beſides other manifeſt Qualities, betwixt ſome Loadſtones and ſome courſe or almoſt ruſty Iron, I am tempted to Conjecture, that thoſe that obſerved this Iron-bar when broken to have acquired a ſtrong Magnetical virtue, which they dreamed not that tract of time might com-

communicate to it, might easily be perswaded, by this virtue and the resemblance of colour, that the Iron was turned into Loadstone: especially they being prepossess'd with that *Aristotelian* Maxim, whence our Author would explain this strange *Phænomenon*, that *inter Symbolum habentia facilis est transmutatio.*

But, leaving this as a bare conjecture, we may take notice, that what virtue an oblong piece of Iron may need a long tract of time to acquire, by the help onely of its position, may be imparted to it in a very short time, by the intervention of such a nimble agent, as the fire. As may be often, though not always, observed in Tongs, and such like Iron Utensils, that, having been ignited, have been set to cool, leaning against some wall or other prop, that kept them in an erected posture, which makes it probable that the great commotion of the parts, made by the vehement heat of the fire, disposed

EXPER. IX.

the Iron, whilſt it was yet ſoft, and had its pores more lax, and parts more pliable, diſpoſed it, I ſay, to receive much quicker impreſſions from the Magnetical *effluvia* of the Earth, than it would have done, if it had ſtill been cold.

EXPER. X. And 'tis very obſervable to our preſent purpoſe, what differing effects are produced by the operation of the fire, upon two Magnetick bodies according to their reſpective conſtitutions. For, by keeping a Loadſtone red-hot, though you cool it afterwards in a perpendicular poſture, you may deprive it of its former power of manifeſtly attracting: But a bar of Iron being ignited, and ſet to cool perpendicularly, does thereby acquire a manifeſt verticity. Of which differing events I muſt not now ſtay to inquire, whether or no the true reaſon be, That the peculiar Texture or internal conſtitution that makes a Loadſtone ſomewhat more than an ordinary Ore of Iron, (which metal,

metal, as far as I have tried, is the uſual ingredient of Loadſtones) being ſpoiled by the violence of the fire, this rude Agent leaves it in the condition of common Iron, or perhaps of ignited Iron-ore: whereas the fire does ſoften the Iron it ſelf (which is a metal not an Ore) agitating its parts, and making them the more flexible, and by relaxing its pores, diſpoſes it to be eaſily and plentifully pervaded by the Magnetical ſteams of the Earth, from which it may not improbably be thought to receive the verticity it acquires; and this the rather, becauſe, as I have often tryed, and elſewhere mentioned, if an oblong Loadſtone, once ſpoil'd by the fire, be thorowly ignited and cooled either perpendicularly, or lying horizontally North and South, it will, as well as a piece of Iron handled after the ſame manner, be made to acquire new poles, or change the old ones, as the skilful experimenter pleaſes.

EXPER. XI.

But whatever be the true cauſe of the diſparity of the fires operation upon a ſound Loadſtone and a bar of Iron, the effect ſeems to ſtrengthen our conjecture, That Magnetical operations may much depend upon Mechanical Principles. And I hope you will find further probability added to it, by ſome Phænomena recited in another paper, to which I once committed ſome promiſcuous Experiments and Obſervations Magnetical.

EXPER. XII.

IF I may be allowed to borrow an Experiment from a little Tract * that yet lyes by me, and has been ſeen but by two or three friends, it may be added to the inſtances already given about the production of Magnetiſm. For in that Experiment I have ſhewn, how having brought a good piece of a certain kind of Engliſh *Oker*, which yet perhaps was no fitter

* *Relating to the Magnetiſm of the Earth.*

fitter than other, to a convenient shape, though, till it was altered by the fire, it discovered no Magnetical Quality; yet after it had been kept red-hot in the fire and was suffered to cool in a convenient posture, it was enabled to exercise Magnetical operations upon a pois'd Needle.

EXPER. XIII.

AS for the Abolition of the Magnetical vertue in a body endow'd with it, it may be made without destroying the Substantial or the Essential Form of the body, and without sensibly adding, diminishing, or altering any thing in reference to the Salt, Sulphur and Mercury, which Chymists presume Iron and Steel, as well as other mixt bodies, to be composed of. For it has been sometimes observed, that the bare continuance of a Loadstone it self in a contrary position to that, which, when freely placed, it seems to effect, has either corrupted or sensibly lessened the vertue of it. What I formerly observed to this purpose I elsewhere relate, and since that having a Loadstone, whose vigor was look'd upon by skilful persons as very extraordinary, and which, whilst it was in an Artificers hand, was therefore held at a high rate, I was careful, being by

by some occasions call'd out of *London*, to lock it up, with some other rarities, in a Cabinet, whereof I took the key along with me, and still kept it in my own Pocket. But my stay abroad proving much longer than I expected, when, being returned to *London*, I had occasion to make use of this Loadstone for an Experiment, I found it indeed where I left it, but so exceedingly decayed, as to its attractive power, which I had formerly examin'd by weight, by having lain almost a year in an inconvenient posture, that if it had not been for the circumstances newly related, I should have concluded that some body had purposely got it out in my absence, and spoiled it by help of the fire, the vertue being so much impaired, that I cared little to employ it any more about considerable Experiments.

EXPER. XIV. And this corruption of the Magnetical vertue, which may in tract of time be made in a Loadstone it self, may in a trice be made by the help of that Stone in an excited Needle. For 'tis observ'd by Magnetical Writers, and my own Trials purposely made have assured me of it, that a well pois'd Needle, being by the touch of a good Loadstone, excited and brought to turn one of its ends to the North and the other

other to the South, it may by a contrary touch of the same Loadstone be deprived of the faculty it had of directing its determinate extreams to determinate Poles. Nay, by another touch (or the same, and even without immediate Contact, if the Magnet be vigorous enough) the Needle may presently have its direction so changed, that the end, which formerly pointed to the North pole, shall now regard the South, and the other end shall instead of the Southern, respect the Northen pole.

EXPER. XV.

AND to make it the more probable, that the change of the Magnetism communicated to Iron may be produc'd at least in good part by Mechanical operations, procuring some change of texture in the Iron; I shall subjoyn a notable Experiment of the ingenious Doctor *Power*, which when I heard of, I tryed as well as I could; and though, perhaps for want of convenience, I could not make it fully answer what it promised, yet the success of the trial was considerable enough to make it pertinent in this place, and to induce me to think, it might yet better succeed with him, whose Experiment, as far as it concerns my present purpose, imports, that if

if a Puncheon, as Smiths call it, or a Rod of Iron, be, by being ignited and ſuffered to cool North and South, and hammered at the ends, very manifeſtly endow'd with Magnetical vertue, this vertue will in a trice be deſtroyed, by two or three ſmart blows of a ſtrong hammer upon the middle of the oblong piece of Iron.

But *Magnetiſm* is ſo fertile a Subject, that if I had now the leiſure and conveniency to range among Magnetical Writers, I ſhould ſcarce doubt of finding, among their many Experiments and Obſervations, divers that might be added to thoſe above delivered, as being eaſily applicable to my preſent Argument. And I hope you will find farther probability added to what has been ſaid, to ſhew, *that Magnetical operations may much depend upon Mechanical Principles*, by ſome *Phænomena* recited in another Paper, to which I once committed ſome promiſcuous Experiments and Obſervations Magnetical.

FINIS.

Experiments and Notes
ABOUT THE
MECHANICAL ORIGINE
OR
PRODUCTION
OF
Electricity.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

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Experiments and Notes
ABOUT THE
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THat 'tis not neceſſary to believe Electrical Attraction (which you know is generally liſted among Occult Qualities) to be the effect of a naked and ſolitary Quality flowing immediately from a Subſtantial Form; but that it may rather be the effect of a Material Effluvium, iſſuing from, and returning to, the Electrical Body (and

perhaps in some cases assisted in its Operation by the external air) seems agreable to divers things that may be observ'd in such Bodies and their manner of acting.

There are differing *Hypotheses* (and all of them Mechanical, propos'd by the Moderns) to solve the Phænomena of Electrical Attraction. Of these Opinions the First is that of the learned Jesuite *Cabæus*, who, though a Peripatetick and Commentator on *Aristotle*, thinks the drawing of light Bodies by Jet, Amber, &c. may be accounted for, by supposing, that the steams that issue, or, if I may so speak, sally, out of Amber, when heated by rubbing, discuss and expell the neighbouring air; which after it has been driven off a little way, makes as it were a small whirlwind, because of the resistance it finds from the remoter air, which has not been wrought on by the Electrical Steams; and that these, shrinking back swiftly enough to the Amber, do in their returns bring along

long with them such light bodies as they meet with in their way. On occasion of which *Hypothesis* I shall offer it to be consider'd, Whether by the gravity of the Atmospherical Air, surmounting the Specifick Gravity of the little and rarifi'd Atmosphere, made about the Amber by its emissions, and comprising the light Body fasten'd on by them, the Attraction may not in divers cases be either caused or promoted.

Another *Hypothesis* is that proposed by that Ingenious Gentleman Sir *Kenelm Digby*, and embraced by the very Learned Dr. *Browne*, (who seems to make our *Gilbert* himself to have been of it) and divers other sagacious men. And according to this *Hypothesis*, the Amber, or other Electrick, being chaf'd or heated, is made to emit certain Rayes or Files of unctuous Steams, which, when they come to be a little cool'd by the external air, are somewhat condens'd, and having lost of their former agitation, shrink back to the

body whence they ſallied out, and carry with them thoſe light bodies, that their further ends happen to adhere to, at the time of their Retraction: As when a drop of Oyl or Syrup hangs from the end of a ſmall ſtick, if that be dextrouſly and cautiouſly ſtruck, the viſcous ſubſtance will, by that impulſe, be ſtretch'd out, and preſently retreating, will bring along with it the duſt or other light bodies that chanced to ſtick to the remoter parts of it.

And this way of explaining Electrical Attractions is employ'd alſo by the Learned *Gaſſendus*, who addes to it, that theſe Electrical Rays (if they may be ſo call'd) being emitted ſeveral ways, and conſequently croſſing one another, get into the pores of the Straw, or other light body to be attracted, and by means of their Decuſſation take the faſter hold of it, and have the greater force to carry it along with them, when they ſhrink back to the Amber

ber whence they were emitted.

A third *Hypotheſis* there is, which was deviſed by the Acute *Carteſius*, who diſlikes the Explications of others, chiefly becauſe he thinks them not applicable to Glaſs, which he ſuppoſes unfit to ſend forth *Effluvia*, and which is yet an Electrical body; and therefore attempts to account for Electrical Attractions by the intervention of certain particles, ſhap'd almoſt like ſmall pieces of Ribbond, which he ſuppoſes to be form'd of this ſubtile matter harbour'd in the pores or creviſes of Glaſs. But this *Hypotheſis*, though ingenious in it ſelf, yet depending upon the knowledge of divers of his peculiar Principles, I cannot intelligibly propoſe it in few words, and therefore ſhall refer you to himſelf for an account of it: which I the leſs ſcruple to do, becauſe though it be not unworthy of the wonted Acuteneſs of the Authour, yet he ſeems himſelf to doubt, whe-

Princip. part 4. Art. 184.

ther it will reach all Electrical Bodies; and it ſeems to me, that the reaſon why he rejects the way of explicating Attraction by the Emiſſion of the finer parts of the attrahent (to which *Hypotheſis*, if it be rightly propoſed, I confeſs my ſelf very inclinable) is grounded upon a miſtake, which, though a Philoſopher may, for want of Experience in that Particular, without diſparagement fall into, is nevertheleſs a miſtake. For whereas our excellent Author ſays, that *Electrical Effluvia*, ſuch as are ſuppoſed to be emitted by Amber, Wax, &c. cannot be imagin'd to proceed from Glaſs, I grant the Suppoſition to be plauſible, but cannot allow it to be true. For as ſolid a body as Glaſs is, yet if you but dextrouſly rub for two or three minutes a couple of pieces of Glaſs againſt one another, you will find that Glaſs is not onely capable of emitting *Effluvia*, but ſuch ones as to be odorous, and ſometimes to be rankly ſtinking.

But

But it is not neceſſary, that in this Paper, where I pretend not to write Diſcourſes but Notes, I ſhould conſider all that has been, or I think may be, ſaid for and againſt each of the above-mentioned *Hypotheſes*; ſince they all agree in what is ſufficient for my preſent purpoſe, namely, that Electrical Attractions are not the Effects of a meer Quality, but of a Subſtantial Emanation from the attracting Body: And 'tis plain, that they all endeavour to ſolve the *Phænomena* in a Mechanical way, without recurring to Subſtantial Forms, and inexplicable Qualities, or ſo much as taking notice of the Hypoſtatical Principles of the Chymiſts. Wherefore it may ſuffice in this place, that I mention ſome *Phænomena* that in general make it probable, that Amber, &c. draws ſuch light Bodies, as pieces of Straw, Hair, and the like, by vertue of ſome Mechanical Affections either of the attracting or of the attracted Bodies, or of both the one and the other.

1. The

1. The first and most general Observation is, That Electrical Bodies draw not unless they be warm'd; which Rule though I have now and then found to admit of an Exception, (whereof I elsewhere offer an account,) yet, as to the generality of common Electricks, it holds well enough to give much countenance to our Doctrine, which teaches the effects of Electrical Bodies to be perform'd by Corporeal Emanations. For 'tis known, that Heat, by agitating the parts of a fit Body, solicites it as it were to send forth its *Effluvia*, as is obvious in odoriferous Gums and Perfumes, which, being heated, send forth their fragrant steams, both further and more copiously than otherwise they would.

2. Next, it has been observ'd, that Amber, &c. warm'd by the fire, does not attract so vigorously, as if it acquire an equal degree of heat by being chaf'd or rub'd: So that the modification of motion in the internal parts, and in the Emanations of the

the Amber, may, as well as the degree of it, contribute to the Attraction. And my particular Observations incline me to adde, that the effect may oftentimes be much promoted, by employing both these ways successively; as I thought I manifestly found when I first warm'd the Amber at the fire, and presently after chaf'd it a little upon a piece of cloth. For then a very few rubbings seem'd to excite it more than many more would otherwise have done: As if the heat of the fire had put the parts into a general, but confus'd, agitation; to which 'twas easie for the subsequent Attrition (or Reciprocation of Pressure) to give a convenient modification in a Body whose Texture disposes it to become vigorously Electrical.

3. Another Observation that is made about these Bodies, is, That they require Tersion as well as Attrition; and though I doubt whether the Rule be infallible, yet I deny not but that weaker Electricks require

quire to be as well wip'd as chaf'd; and even good ones will have their Operation promoted by the ſame means. And this is very agreeable to our Doctrine, ſince Terſion, beſides that it is, as I have ſometimes manifeſtly known it, a kind or degree of Attrition, frees the Surface from thoſe adherences that might choak the pores of the Amber, or at leaſt hinder the emanation of the ſteams to be ſo free and copious as otherwiſe it would be.

4. 'Tis likewiſe obſerv'd, That whereas the Magnetical Steams are ſo ſubtile, that they penetrate and perform their Operation through all kind of Mediums hitherto known to us; Electrical Steams are like thoſe of ſome odoriferous Bodies, eaſily check'd in their progreſs, ſince 'tis affirm'd by Learned Writers, who ſay they speak upon particular Trial, that the Interpoſition of the fineſt Linnen or Sarcenet is ſufficient to hinder all the Operation of excited Amber upon a Straw or Feather placed

plac'd never ſo little beyond it.

5. It has been alſo obſerved, that the effects of Electrical Attraction are weaken'd if the air be thick and cloudy; and eſpecially if the South-wind blows: And that Electricks diſplay their vertue more faintly by night than by day, and more vigorouſly in clear weather, and when the winds are Northerly. All which the Learned *Kircherus* aſſerts himſelf to have found true by experience; inſomuch that thoſe bodies that are but faintly drawn when the weather is clear, will not, when 'tis thick and cloudy, be at all moved.

6. We have alſo obſerved, That divers Concretes, that are notably Electrical, do abound in an effluviable matter (if I may ſo call it) which is capable of being manifeſtly evaporated by heat and rubbing. Thus we ſee, that moſt Reſinous Gums, that draw light bodies, do alſo, being moderately ſolicited by heat, (whether this be excited by the fire, or by Attrition or Contuſion)

on) emit ſteams. And in pieces of *Sulphur* conveniently ſhaped, I found upon due Attrition a Sulphureous ſtink. And that piece of Amber which I moſt employ, being ſomewhat large and very well poliſh'd, will, being rub'd upon a piece of woollen cloth, emit ſteams, which the noſtrils themſelves may perceive; and they ſometimes ſeem to me not unlike thoſe that I took notice of, when I kept in my mouth a drop or two of the diluted Tincture (or Solution of the finer parts) of Amber made with Spirit of Wine, or of Sal Armoniac.

7. It agrees very well with what has been ſaid of the corporeal Emanations of Amber, that its attractive power will continue ſome time after it has been once excited. For the Attrition having caus'd an inteſtine commotion in the parts of the Concrete, the heat or warmth that is thereby excited ought not to ceaſe, as ſoon as ever the rubbing is over, but to continue capable of emitting

Effluvia

Effluvia for some time afterwards, which will be longer or shorter according to the goodness of the Electric, and the degree of the Antecedent commotion: which joyn'd together may sometimes make the effect considerable, insomuch that in a warm day, about noon, I did with a certain body, not much, if at all, bigger than a Pea, but very vigorously attractive, move to and fro a Steel Needle freely poysed, about three minutes (or the twentieth part of an hour) after I had left off rubbing the Attrahent.

8. That it may not seem impossible, that Electrical *Effluvia* should be able to insinuate themselves into the pores of many other bodies, I shall adde, that I found them subtile enough to attract not onely Spirit of Wine, but that fluid aggregate of Corpuscles we call Smoak. For having well lighted a Wax-taper, which I preferr'd to a common Candle to avoid the stink of the snuff, I blew out the flame; and, when the smoak ascend-

aſcended in a ſlender ſtream, held, at a convenient diſtance from it, an excited piece of Amber or a chafed Diamond, which would manifeſtly make the aſcending ſmoak deviate from its former line, and turn aſide, to beat, as it were, againſt the Electric, which, if it were vigorous, would act at a conſiderable diſtance, and ſeemed to ſmoak for a pretty while together.

9. That 'tis not in any peculiar Sympathy between an Electric and a body whereon it operates, that Electrical Attraction depends, ſeems the more probale, becauſe Amber, for inſtance, does not attract onely one determinate ſort of bodies, as the Loadſtone does Iron, and thoſe bodies wherein it abounds; but as far as I have yet tried, it draws indifferently all bodies whatſoever, being plac'd within a due diſtance from it, (as my choiceſt piece of Amber draws not onely Sand and Mineral Powders, but Filings of Steel and Copper, and beaten Gold it ſelf) pro-

provided they be minute or light enough, except perhaps it be fire: I employ the word *perhaps*, because I am not yet so clear in this point. For having applied a strong Electric at a convenient distance to small fragments of ignited matter, they were readily enough attracted, and shin'd, whilst they were sticking to the body that had drawn them: But when I look'd attentively upon them, I found the shining sparks to be, as it were, cloath'd with light ashes, which, in spite of my diligence, had been already form'd about the attracted Corpuscles, upon the expiring of a good part of the fire; so that it remain'd somewhat doubtful to me, whether the ignited Corpuscles, whilst they were totally such, were attracted; or whether the immediate objects of the Attraction were not the new form'd ashes, which carried up with them those yet unextinguished parts of fire, that chanc'd to be lodg'd in them. But, as for flame, our Countreyman

Gilbert delivers as his Experiment, That an Electric, though duly excited and applied, will not move the flame of the slendereſt Candle. Which ſome will think not ſo eaſie to be well tried with common Electricks, as Amber, hard Wax, Sulphur, and the like unctuous Concretes, that very eaſily take fire: Therefore I choſe to make my Trial with a rough Diamond extraordinarily attractive, which I could, without injuring it, hold as near as I pleas'd to the flame of a Candle or Taper; and though I was not ſatisfi'd that it did either attract the flame, as it viſibly did the ſmoak, or manifeſtly agitate it; yet granting that *Gilbert*'s Aſſertion will conſtantly hold true, and ſo, that flame is to be excepted from the general Rule, yet this exception may well comport with the *Hypotheſis* hitherto countenanc'd, ſince it may be ſaid, as 'tis, if I miſtake not, by *Kirkerus*, that the heat of the flame diſſipates the *Effluvia*, by whoſe means the Attracti-

traction ſhould be perform'd. To which I ſhall adde, that poſſibly the Celerity of the motion of the Flame upwards, may render it very difficult for the Electrical Emanations to divert the Flame from its Courſe.

10. We have found by *Experiment*, That a vigorous and well excited piece of Amber will draw, not onely the powder of Amber, but leſs minute fragments of it. And as in many caſes one contrary directs to another, ſo this Trial ſuggeſted a further, which, in caſe of good ſucceſs, would probably argue, that in Electrical Attraction not onely *Effluvia* are emitted by the Electrical body, but theſe *Effluvia* falten upon the body to be drawn, and that in ſuch a way, that the intervening viſcous ſtrings, which may be ſuppoſed to be made up of thoſe cohering *Effluvia*, are, when their agitation ceaſes, contracted or made to ſhrink inwards towards both ends, almoſt as a highly ſtretch'd Lute-ſtring does when 'tis permitted to retreat into

ſhorter Dimenſions. But the Conjecture it ſelf was much more eaſie to be made than the Experiment requiſite to examine it. For we found it no eaſie matter to ſuſpend an Electric, great and vigorous enough, in ſuch a manner, that it might, whilſt ſuſpended, be excited, and be ſo nicely poiſed, that ſo faint a force as that wherewith it attracts light bodies ſhould be able to procure a Local Motion to the whole Body it ſelf. But after ſome fruitleſs attempts with other Electricks, I had recourſe to the very vigorous piece of poliſh'd Amber, formerly mention'd, and when we had with the help of a little Wax ſuſpended it by a ſilken thread, we chafed very well one of the blunt edges of it upon a kind of large Pin-cuſhion cover'd with a courſe and black woollen ſtuff, and then brought the Electric, as ſoon as we could, to ſettle notwithſtanding its hanging freely at the bottom of the ſtring. This courſe of rubbing on the edge of the Amber we pitch'd upon

upon for more than one reaſon; for if we had chafed the flat ſide, the Amber could not have approached the body it had been rub'd on without making a change of place in the whole Electric, and, which is worſe, without making it move (contrary to the nature of heavy bodies) ſomewhat upwards; whereas the Amber having, by reaſon of its ſuſpenſion, its parts counterpoiſed by one another; to make the excited edge approach to another body, that edge needed not at all aſcend, but onely be moved horizontally, to which way of moving the gravity of the Electric (which the ſtring kept from moving downwards) could be but little or no hinderance. And agreeably to this we found, that if, as ſoon as the ſuſpended and well rubb'd Electric was brought to ſettle freely, we applied to the chafed edge, but without touching it, the lately mention'd Cuſhion, which, by reaſon of its rough *Superficies* and poroſity, was fit for the Electrical

Effluvia to faſten upon, the edge would manifeſtly be drawn aſide by the Cuſhion ſteadily held, and if this were ſlowly removed, would follow it a good way; and when this body no longer detain'd it, would return to the poſture wherein it had ſettled before. And this power of approaching the Cuſhion by vertue of the operation of its own ſteams, was ſo durable in our vigorous piece of Amber, that by once chafing it, I was able to make it follow the Cuſhion no leſs than ten or eleven times. Whether from ſuch Experiments one may argue, that 'tis but, as 'twere, by accident that Amber attracts another body, and not this the Amber; and whether theſe ought to make us queſtion, if Electricks may with ſo much propriety, as has been hitherto generally ſuppoſed, be ſaid to *Attract*, are doubts that my Deſign does not here oblige me to examine.

Some other *Phænomena* might be added of the ſame Tendency with thoſe

those already mention'd, (as the advantage that Electrical Bodies usually get by having well polish'd or at least smooth Surfaces,) but the Title of this Paper promising some *Experiments* about the *Production* of Electricity, I must not omit to recite, how I have been sometimes able to produce or destroy this Quality in certain bodies, by means of alterations, that appear'd not to be other than Mechanical.

EXPER. I.

And first, having with a very mild heat slowly evaporated about a fourth part of good Turpentine, I found, that the remaining body would not, when cold, continue a Liquor, but harden'd into a transparent Gum almost like Amber, which, as I look'd for, proved Electrical.

EXPER. II.

SEcondly, by mixing two such liquid Bodies as *Petroleum* and strong Spirit of Nitre in a certain proportion, and then distilling them till there remained a dry mass, I obtain'd a brittle substance as black as Jet; and whose Superficies (where it was contiguous to the Retort) was glossie like that Mineral when polished; and as I expected I found it also to resemble Jet, in being endowed with an Electrical Faculty.

EXPER. III.

THirdly, Having burnt Antimony to ashes, and of those ashes, without any addition, made a transparent Glass, I found, that, when rubb'd, as Electrical Bodies ought to be to excite them, it answer'd my expectation, by manifesting a not inconsiderable Electricity. And this is the worthier of notice, because, that *as a*

Vitrum

Vitrum Antimonii, that is ſaid to be purer than ordinary, may be made of the *Regulus* of the ſame Mineral, in whoſe preparation you know a great part of the Antimonial Sulphur is ſeparated and left among the *Scoriæ*; ſo Glaſs of Antimony made without additament, may eaſily, as experience has inform'd us, be in part reduc'd to a *Regulus*, (a Body not reckon'd amongſt Electrical ones.) And that you may not think, that 'tis onely ſome peculiar and fixt part of the Antimony that is capable of *Vitrification*, let me aſſure you, that even with the other part that is wont to flye away, (namely the Flowers) an Antimonial Glaſs may without an addition of other Ingredients be made.

EXPER. IV.

FOurthly, The mention of a Vitrified Body brings into my mind, that I more than once made ſome Glaſs of Lead *per ſe*, (which

I found no very easie work) that also was not wholly destitute of an Electrical Vertue, though it had but a very languid one. And it is not here to be overlook'd, that this Glass might easily be brought to afford again malleable Lead, which was never reckon'd, that I know of, among Electrical Bodies.

EXPER. V.

Fifthly, Having taken some Amber, and warily distill'd it, not with Sand or powder'd Brick, or some such additament as Chymists are wont to use, for fear it should boyl over or break their Vessels; but by its self, that I might have an unmixed *Caput mortuum*; Having made this Distillation, I say, and continued it till it had afforded a good proportion of phlegm, Spirit, Volatile Salt, and Oyl, the Retort was warily broken, and the remaining matter was taken out in a lump, which, though it had quite lost its colour being burnt

burnt quite black, and though it were grown ſtrangely brittle in compariſon of Amber, ſo that they who believe the vertue of attracting light Bodies to flow from the ſubſtantial form of Amber, would not expect it in a Body ſo changed and deprived of its nobleſt parts: Yet this *Caput mortuum* was ſo far from having loſt its Electrical Faculty, that it ſeemed to attract more vigorouſly than Amber it ſelf is wont to do before it be committed to Diſtillation.

And from the foregoing Inſtances afforded us by the Glaſs of Antimony, we may learn, that when the form of a Body ſeems to be deſtroyed by a fiery *Analyſis* that diſſipates the parts of it, the remaining ſubſtance may yet be endowed with Electricity, as the *Caput mortuum* of Amber may acquire it; as in the caſe of the Glaſs of Antimony made of the *Calx* and of the Flowers. And from the ſecond Example abovementioned, and from common Glaſs which is Electrical, we may alſo learn,

learn, that Bodies that are neither of them apart obſerved to be endowed with Electricity, may have that Vertue reſult in the compounded ſubſtance that they conſtitute, though it be but a factitious Body.

To the foregoing Experiments, whoſe Succeſs is wont to be uniform enough, I ſhall adde the Recital of a ſurpriſing *Phænomenon*, which, though not conſtant, may help to make it probable, that Electrical Attractions need not be ſuppos'd ſtill to proceed from the ſubſtantial, or even from the eſſential Form of the Attrahent; but may be the effects of unheeded, and, as it were, fortuitous Cauſes. And however, I dare not ſuppreſs ſo ſtrange an Obſervation, and therefore ſhall relate that which I had the luck to make of an odd ſort of Electrical Attraction (as it ſeem'd,) not taken notice of (that I know of) by any either Naturaliſt or other Writer, and it is this.

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EXPER. VI.

THat falſe Locks (as they call them) of ſome Hair, being by curling or otherwiſe brought to a certain degree of drineſs, or of ſtiffneſs, will be attracted by the fleſh of ſome perſons, or ſeem to apply themſelves to it, as Hair is wont to do to Amber or Jet excited by rubbing. Of this I had a Proof in ſuch Locks worn by two very Fair Ladies that you know. For at ſome times I obſerved, that they could not keep their Locks from flying to their Cheeks, and (though neither of them made any uſe, or had any need of Painting) from ſticking there. When one of theſe Beauties firſt ſhew'd me this Experiment, I turn'd it into a Complemental Raillery, as ſuſpecting there might be ſome trick in it, though I after ſaw the ſame thing happen to the others Locks too. But as ſhe is no ordinary *Virtuoſa*, ſhe very

ry ingeniouſly remov'd my ſuſpicions, and (as I requeſted) gave me leave to ſatisfie my ſelf further, by deſiring her to hold her warm hand at a convenient diſtance from one of thoſe Locks taken off and held in the air. For as ſoon as ſhe did this, the lower end of the Lock, which was free, applied it ſelf preſently to her hand: which ſeem'd the more ſtrange, becauſe ſo great a multitude of Hair would not have been eaſily attracted by an ordinary Electrical Body, that had not been conſiderably large, or extraordinarily vigorous. This repeated Obſervation put me upon inquiring among ſome other young Ladies, whether they had obſerved any ſuch like thing, but I found little ſatisfaction to my Queſtion, except from one of them eminent for being ingenious, who told me, that ſometimes ſhe had met with theſe troubleſome Locks; but that all ſhe could tell me of the Circumſtances, which I would have been inform'd about, was, that they ſeem'd to her

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to flye moſt to her Cheeks when they had been put into a ſomewhat ſtiff Curle, and when the Weather was frosty *.

* Some years after the making the Experiments about the Production of *Electricity*, having a deſire to try, whether in the Attractions made by Amber, the motions excited by the air had a conſiderable Intereſt, or whether the Effect were not due rather to the Emiſſion and Retraction of Effluvia, which being of a viſcous nature may conſiſt of Particles either branch'd or hookt, or otherwiſe fit for ſome kind of Cohefion, and capable of being ſtretch'd, and of ſhrinking again, as Leather Thongs are: To examine this, I ſay, I thought the fitteſt way, if 'twere practicable, would be, to try, whether Amber would draw a light Body in a Glaſs whence the air was pumpt out. And *though* the Trial of this ſeem'd very difficult to make, and we were ſomewhat diſcouraged by our firſt attempt, wherein the weight of the ambient air broke our Receiver, which chanced to prove too weak, when the internal air had been with extraordinary diligence pumpt out; *yet* having a vigorous piece of Amber, which I had caus'd to be purpoſely turn'd and poliſh'd for

for Electrical Experiments, I afterwards repeated the Trial, and found, that in warm Weather it would retain a manifest power of attracting for several minutes (for it stirred a pois'd Needle after above ¼ of an hour) after we had done rubbing it. Upon which encouragement we suspended it, being first well chafed, in a Glass Receiver that was not great, just over a light Body; and making haste with our Air-Pump to exhaust the Glass, when the Air was withdrawn, we did by a Contrivance let down the suspended Amber till it came very near the Straw or Feather, and perceived, as we expected, that in some Trials, upon the least Contact it would lift it up; and in others, for we repeated the Experiment, the Amber would raise it without touching it, that is, would attract it.

You will probably be the less dispos'd to believe, That Electrical Attractions must proceed from the Substantial Forms of the Attrahents, or rom the Predominancy of this or that Chymical Principle in them, if I acquaint you with some odd Trials wherein the Attraction of light Bodies

dies seem'd to depend upon very small circumstances. And though forbearing at present, to offer you my thoughts about the cause of these surprising *Phænomena*, I propose it onely as a Probleme to your self and your curious Friends, yet the main circumstances seeming to be of a Mechanical Nature, the recital of my Trials will not be impertinent to the Design and Subject of this Paper.

EXPER. VII.

I Took then a large and vigorous piece of Amber conveniently shaped for my purpose, and a downy feather, such as grows upon the Bodies, not Wings or Tails of a somewhat large Chicken: Then having moderately excited the Electrick, I held the Amber so near it, that the neighbouring part of the feather was drawn by it and stuck fast to it; but the remoter parts continued in their former posture. This done, I applyed my fore-finger to these erected

downy feathers, and immediately, as I expected, they left their preceeding posture, and applied themselves to it as if it had been an Electrical Body. And whether I offered to them my nail, or the pulpy part of my finger, or held my finger towards the right hand or the left, or directly over, these downy feathers that were near the little Quill did nimbly, and, for ought appear'd, equally turn themselves towards it, and fasten themselves to it. And to shew that the steams that issued out of so warm a Body as my finger were not necessary to attract (as men speak) the abovementioned feathers, instead of my finger, I applied to them, after the same manner, a little Cylindrical Instrument of Silver, to which they bowed and fastened themselves as they had done to my finger, though the tip of this Instrument were presented to them in several postures. The like success I had with the end of an Iron Key, and the like also with a cold piece of polish'd black Marble; and sometimes the

the feathers did ſo readily and ſtrongly faſten themſelves to theſe extraneous and unexcited Bodies, that I have been able (though not eaſily) to make one of them draw the feather from the Amber it ſelf.

But it is diligently to be obſerv'd, that this unuſual attraction happened onely whilſt the electrical operation of the excited Amber continued ſtrong enough to ſuſtain the feathers. For afterwards, neither the approach of my finger, nor that of the other bodies, would make the downy feathers change their poſture. Yet as ſoon as ever the Amber was by a light affriction excited again, the feather would be diſpoſed to apply it ſelf again to the abovementioned Bodies.

And leſt there ſhould be any peculiarity in that particular feather, I made the Trials with others (provided they were not long enough to exceed the ſphere of activity of the Amber) and found the Experiment to anſwer my expectation.

I made the Experiment alſo at differing times, and with ſome months, if not rather years, of interval, but with the like ſucceſs.

And leſt you ſhould think theſe *Phænomena* proceed from ſome peculiarity in the piece of Amber I employed, I ſhall add, that I found uniformity enough in the ſucceſs, when, in the place of Amber, I ſubſtituted another Electrick, and particularly a ſmooth maſs of melted Brimſtone.

Theſe are the *Phænomena* I thought fit to mention at preſent of this unuſual way of drawing light bodies, and with this Experiment I ſhould conclude my Notes about Electricity, but that I think it will not be amiſs before I take leave of this Subject, to give this Advertiſement, That the event of Electrical Experiments is not always ſo certain as that of many others, being ſometimes much varied by ſeemingly ſlight circumſtances, and now and then by ſome that are altogether over-look'd. This Obſervation may receive credit from ſome of the

the particulars above recited (especially concerning the interest of the weather, *&c.* in Electrical *Phænomena.*) But now I shall add, that, not onely there may happen some variations in the success of Trials made with Electrical Bodies, but that it is not so certain as many think, whether some particular Bodies be or be not Electrical. For the inquisitive *Kircherus* reckons Crystall among those Gems to whom Nature has denyed the attractive power we are speaking of; and yet I remember not, that, among all the trials I have made with native Crystall, I have found any that was destitute of the power he refuses them. Also a late most learned Writer reciting the Electricks, reckon'd up by our industrious Countryman *Gilbert*, and increasing their number by some observed by himself, (to which I shall now add, besides white Saphyrs, and white English Amethysts, the almost Diaphanous spar of Lead Ore) denies Electricity to a couple of transparent Gems, the Cornelion and the Emrald. And I do the less wonder he should do so to the former, because I have my self in vain tried to make any attraction with a piece of Cornelion so large and fair, that 'twas kept for a rarity; and yet with divers other fine Cornelions I have been able to attract some light bodies very manifestly,

ly, if not briskly; and I uſually wear a Cornelian Ring, that is richly enough endowed with Electricity. But as for Emralds, as I thought it ſtrange that Nature ſhould have denied them a Quality ſhe has granted to ſo many other Diaphanous Gems, and even to Cryſtal, ſo I thought the aſſertion deſerved an *Examen*, upon which I concluded, that at leaſt it does not univerſally and conſtantly hold true. I had indeed ſeen in a Ring a Stone of price and great luſtre, which, though green, I found to be, (as I gueſs'd it would prove) vigorouſly enough Electrical. But this Experiment, though ſeemingly concluſive, I did not look upon as a fair trial, becauſe the Stone was not a true Emrald, but, which is rare, a green Saphir. And I learned by inquiry of the skillful Jeweller that cut it, that it was ſo far from having the ſoftneſs of an Emrald, that he found it harder than blew Saphyrs themſelves, which yet are Gems of great hardneſs, and by ſome reputed ſecond to none, but Diamonds. Without therefore concluding any thing from this Experiment, ſave that, if the aſſertion I was to examin were true, the want of an Electrical faculty might be thought a Concomitant rather of the peculiar Texture of the Emrald than of its green colour, I proceeded

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to make trial with three or four Emralds, whose being true was not doubted, and found them all somewhat, though not equally, endow'd with Electricity, which I found to be yet more considerable in an Emrald of my own, whose colour was so excellent, that by skilful persons 'twas look'd on as a rarity. And though, by this success of my inquiry, I perceived I could not, as else I might have done, shew the Curious a new way of judging of true and false Emralds, yet the like way may be, though not always certain, yet oftentimes of use, in the estimating whether Diamonds be true or counterfeit, especially, if, being set in Rings, the surest way of trying them cannot conveniently be employed. For whereas Glass, though it have some Electricity, seems, as far as I have observed, to have but a faint one, there are often found Diamonds that have a very vigorous one. And I do not remember I met with any Electrick of the same bulk, that was more vigorous than a rough Diamond I have, which is the same that I formerly mentioned to have moved a Needle above three minutes after I had ceased to chafe it. And this brings into my mind, that it has been observed, that Diamonds draw better whilst rough, than they do after they are cut and polish'd,

poliſh'd; which ſeeming to contradict what has been obſerved by others and by us alſo, that Amber, for inſtance, attracts more vigorouſly if the ſurface be made very ſmooth than otherwiſe, it induces me to conjecture, that, if this Obſervation about Diamonds be true, as ſome of my trials have now and then inclined me to think it, and if it do not in ſome caſes conſiderably depend upon the loſs of the (Electrical) Subſtance of the Stone, by its being cut and ground, the Reaſon may poſſibly be, that the great rapidneſs with which the Wheels that ſerve to cut and poliſh Diamonds muſt be mov'd, does excite a great degree of heat, (which the ſenſes may eaſily diſcover) in the Stone, and by that and the ſtrong concuſſion it makes of its parts, may force it to ſpend its effluviable matter, if I may ſo call it, ſo plentifully, that the Stone may be impoveriſh'd, and perhaps alſo, on the account of ſome little change in its Texture, be rendred leſſe diſpoſed to emit thoſe *effluvia* that are Inſtruments of Electrical Attraction. But as I willingly leave the matter of Fact to further Trial, ſo I do the Cauſe of it, in caſe it prove true, to farther Inquiry.

FINIS.